ABSTRACT

ENVIRONMENTAL AND ECONOMIC IMPACT OF
UNDERGROUND STORAGE TANKS IN THE
UNITED STATES AND TERRITORIES

By

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The existing population of Underground Storage Tanks (USTs) in the United States is enormous. The three major problems relating to (USTs) which must be addresses by communities and UST owners are: (1) the large number of aged USTs in the United States without adequate leak protection, (2) the risks associated with UST management and (3) the rising costs of UST remediation and regulation requirements. The consequences of using USTs for storage of liquid fuels and chemicals are addresses in this paper. The discussion involves such parameters as age, material, product, corrosion, location and quantity. All of these parameters have a direct influence on the environmental and economic impact of USTs in the United States. It will be seen that while age, material and corrosion play a

major role in the number of leaking USTs; product, location and quantity are major factors associated with the impacts of those leaks.

This paper discusses the number of existing USTs and the percentage of those that are leaking. It also presents the costs asscciated with the remediation of those leaks and the separate costs of replacing or updating old USTs to meet the new Environmental Protection Agency (EPA) regulations.

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CHAPTER 1

INTRODUCTION

The use of tanks for storing liquid fuels has been a common practice for many years. The placement of these tanks underground, has been going on for well over forty years. (A tank is considered to be an underground storage tank (UST) if 10% or more of its volume, including piping, is underground). Savings in space, safety from fire and explosions, and visual aesthetics were some obvious advantages to locating tanks underground. However, such use as liquid storage vessels has not been without problems. Today, the environmental impact of leaking fuel from USTs into the ground water and soil poses significant issues; only very recently have corrective measures been taken.

Without regulations as a guide, the practice of placing tanks underground went virtually unchecked for more than 40 years. The result was literally millions of underground tanks. Determining the exact numbers and locations of USTs is an enormous task which may never be realized, simply because there was until recently no requirement to maintain records for them. Many are no longer in use, some have been forgotten and a goodly number are leaking.

The number of USTs leaking is truly an unknown. More precise statistics have been tallied since mandatory reporting and registration of USTs was required by Congress in 1984 under Subtitle I of the Resource Conservation and Recovery Act (RCRA). Clearly, however, those forgotten may never be counted. By 1992, over 25 states cited leaking USTs as the #1 threat to the nations ground water [5]. (Unless otherwise noted, the word nation as used in this paper will include all of the United States and the territories; Guam, Virgin Islands and Puerto Rico). Leaking USTs not only contaminate ground water, but also threaten public safety. Explosions, fires, and contaminated soil are common hazards associated with leaking USTs. Cleanup costs associated with leaking USTs are considerable and escalate with time and ongoing leakage. While there are still advantages in placing tanks underground for storage of liquid fuels, the expenses related to new environmental rules have likewise dramatically multiplied the cost of doing business using USTs.

Regulations implemented by the environmental protection agency (EPA) in the Code of Federal Regulations (40 CFR, parts 280 and 281), as a result of RCRA, require leak detection, financial responsibility (to cover mitigation costs in case of leakage), and accountability records for USTs. These regulations require management of both newly installed and existing USTs. Older USTs must thus be upgraded to meet the new regulations for leak detection, financial responsibility, and accountability records. In view of the high cost of upgrade, replacement of the tank is often the most economical solution. The more serious problem may well be that the regulators are relying on the regulated far too much for registration and leakage data input. If not a classic case of the fox guarding the hen house, it is at least a most troubling aspect of this national debt-like dilemma.

CHAPTER 2

A PERSPECTIVE ON THE PROBLEM

Overview

The following background data collected on USTs includes information on numbers of tanks placed underground for liquid fuel storage, types of materials used for tank construction, tank sizes, products stored, regulated versus unregulated UST, corrosion concerns and the best insight on the scope of the leakage problem.

Current statistics are by no means all inclusive and do not include every underground storage tank in this country. The largest obstacle in obtaining data was the many inconsistencies detected in the various reference sources. There was no agreement at all as to the exact number of USTs nationwide. Each reference gave only estimates; some used ranges while others offered approximate amounts. For example, reference 5 estimated 326,000 motor fuel storage tanks, adding that the EPA believed at least one third of these tanks are leaking. Reference 18 indicates that there are an estimated 5 million USTs across the country and that about one in four is leaking. This source does not describe the contents or use of the tanks and bases its 5 million on an estimate from a specialist with the New York based Environmental Defense Fund (EDF). In sharp contrast, reference 24 asserts a range of USTs on the order of 7 to 15 million nationwide. This estimate includes all regulated and unregulated tanks: tanks used for heating oil for homes (3 to 5 million), commercial use (1 to 2 million), motor fuel storage and regulated tanks (2 million), and an unknown number of UST at industrial sites for chemical storage and flow through manufacturing processes which store waste water. Even the figures from government agencies are questionable, despite the implementation of UST regulations under 40 CFR, requiring compilation of information into an updated data base of all tanks under their jurisdiction. On a regular basis, agencies report discoveries of USTs not previously recorded.

One fact is inescapable: no one knows for certain the quantity of USTs buried beneath our crust. Determining the exact number is beyond the scope of this paper and probably not terribly relevant to the solutions suggested herein.

Leaks

How many USTs are really leaking? The wide ranging estimates of total USTs make determining exact numbers of leaking USTs impossible. However, for purposes of this paper, estimated percentages will be used based on a statistical sample of some recently collected data, correlated with tank ages and known numbers of leaking tanks for a specific group.

Construction of USTs

There is little data describing the types of UST construction material other than to report that most of the tanks were constructed of steel in the 1950s and 1960s. Fiberglass Reinforced Plastic (FRP) was increasingly used in the 1970s and 1980s. Other types of material included plastic, steel coated with plastic or FRP, and concrete tanks. All of these materials have likewise been used in tank replacement projects over the years.

Products Stored in USTs

USTs are used for the storage of many types of liquids including various industrial chemicals and petroleum products such as gasoline, JP5 and diesel fuel. This paper will concentrate on the approximately two million USTs regulated by the EPA which contain, for the most part, petroleum products. The majority of the USTs so regulated are auto/truck gasoline and diesel fuel storage tanks at service stations.

Regulated vs. Unregulated

Of the close to two million regulated USTs, 97 percent are used for storage of petroleum products with the majority containing gasoline. The other 3 percent include one or more of 701 chemicals listed under the Comprehensive Environmental Response Compensation Liability Act (CERCLA), also know as the Superfund Act [25]. With estimates of up to 15 million USTs, one might ask why are not more tanks being regulated by the EPA? The answer lies in 40 CFR parts 280 and 281 wherein regulations under Subtitle I of RCRA. This section excludes farm or residential tanks of 1100 gallons or less storing motor fuel for non-commercial uses, tanks storing heating oils for use on the premises where stored, septic tanks, pipeline facilities regulated under the Natural Gas Pipeline Safety Act or other comparable state statutes, flow through process tanks, storage tanks placed on or above the floor of underground areas such as basements or cellars, and tanks containing hazardous wastes regulated under RCRA Subtitle C.

The EPA estimates the number of unregulated tanks to be about 3.1 million, 2.7 million farm and residential fuel tanks under 1,100 gallons and 0.4 million heating oil tanks. Justification for non-regulation is premised upon four rationale: (1) most are owned by home owners with little expertise or finances to implement new regulations, (2) the EPA has no significant mechanism yet in place to regulate these extra tanks (3) uniform regulations throughout the nation may be inappropriate because problems associated with these tank systems vary from area to area, and (4) state and local governments can better regulate these tanks based on localized conditions and problems [25].

The EPA's total estimate for regulated and unregulated USTs is thus about 5.1 million USTs. Most likely the actual number is significantly higher, primarily there is no reporting requirement for unregulated tanks while in the regulated category there may be hundreds of thousands (millions) of forgotten or overlooked tanks.

Leaking USTs

Leaking USTs are becoming the environmental issue. "These leaking USTs, spell trouble with a capital T," is a typical comment made today when referring to USTs. Reports citing a petroleum ocean of 250 million gallons of gasoline under a Chevron refinery in California which leaked from USTs on the site and an underground petroleum lake of 17 million gallons at a site in New York are but a few examples of this immense dilemma. But even small leaks that go unchecked can be catastrophic to the environment due to the contamination potential. There is also substantial risk of explosions resulting from buildup of gas vapors in basements, underground storm drains, and sewers.

The largest concern to the environment at this time is that of contaminating the nation's groundwater. The leaking of one and one half cups of petroleum per hour can contaminate one million gallons of water in a day [18]. Cleanup costs associated with petroleum contaminated water are enormous; typically in the $100,000 to $1,000,000 range. Of the two million regulated USTs, the EPA estimates about 25 percent are non-tight. This estimate is based on various studies performed by states with local UST programs and commercial UST users. These studies show that, depending on location, material used, installation method and maintenance program, between 11 and 48 percent of the USTs leaked. The regulated USTs are located at about 750,000 sites throughout the nation. Of these sites, at least 100,000 have confirmed releases of hazardous liquids into the ground. The majority of these leaks come from single walled, steel tanks over 16 years old [9]. Most existing USTs are made of bare steel [25]. Tank failure history shows that when these steel tanks do leak from corrosion, it is almost always from external corrosion. Of all the current causes of releases, corrosion is by far the major contributor [4].

Tank Construction

A very recent EPA survey based upon reports by tank owners in 56 states and territories shows that about 4 out of 5 tanks are made of steel. This survey was conducted in 1990 and updated April 1991 and includes all ages of regulated USTs from 0 to greater than 25 years old. Roughly 25 percent of these steel tanks are over quarter of a century old.

Fiberglass Reinforced Plastics (FRP), on the other hand, make up only ten percent of the existing USTs. Of these, roughly 50 percent are under 5 years of age. The popularity of FRP is, however, increasing, as indicated by this last figure. Concrete is another material used to construct USTs, but it is encountered in relatively low numbers. Extended use data on other materials used for USTs is not available.

New construction materials and methods are in various stages of development. The use of steel tanks covered with a plastic coat, steel-FRP composite, and combinations of these with cathodic protection on the steel tank are some of these innovations. One new tank, called the STI-P3, is a steel tank with an external non-corrodible coating and a factory-applied metal anode that sacrifices itself to protect any bare spots on the tank. The tank vessel is also electrically isolated from the attached piping. The only documented failures associated with this new tank have been attributed to improper installation [4]. Steel-FRP composite tanks have not been used as much as the FRP or coated and cathodically protected tanks. About 65,000 steel FRP USTs have been installed and no reported corrosion-related failures have occurred. As more externally corrosion resistant tanks become available, the threat of internal corrosion may well take over as the primary cause of tank failure. A recently sought patent [19] shows an air pressurized void between the inner and outer walls of a double wall tank that will plug any holes as they develop and signal the leak due to the drop in air pressure between the walls as indicated on a pressure gage.

The need to develop a leak-proof UST is significant for it will provide a safe and effective method of storing fuels underground.

The problems associated with leaking USTs are many. The difference in soils, climate, seismology and ground water levels from area to area are just some of the variables that have to be taken into consideration when designing a tank for underground use. The most abundant material used for UST construction is steel. The current estimate by the EPA for regulated USTs is about 1.6 million steel tanks. FRP constructed tanks is second at about 200,000; concrete constructed tanks at about 15,000 and the unknown and other category at about 300,000. Of the tanks construc-ed of steel, the major concern at this point is corrosion, both internal and external. Of the approximately 1.5 million steel USTs about 1 in 8 has some known form of protection either internal, external, cath-odic or any combination of the three. Surveys by the EPA show that the failure rate of tanks using new materials and new methods of protection is very rare. The failure rate of all existing FRP tanks is estimated to be about 1/2 of one percent. Of those FRP tanks that failed, the one main factor contributing to the failures has been improper installation practices.

Fiberglass Reinforced Plastic tanks are considered to be rust free. Installation of FRP tanks underground is however considered to be critical in preventing future leaks. A small object such as a stone in the bed of an FRP tank can in time cause a stress fracture and failure. Surveys show that if an FRP tank fails from improper installation it will typically fail within the first year of installation.

Corrosion

The actual number of leaking USTs is unknown but what is known is that the number one cause is corrosion. Most existing USTs are made of material that is not corrosion resistant, mainly steel. But even those UST systems with corrosion protection experience failure due to such problems as imperfections in the coating or taping setup. Depletion of sacrificial anodes, inadvertent interruption of impressed current, or corrosion from inside by the stored product, likewise account for leakage.

The EPA estimates that there were over 450,000 UST systems in use as of October 1988, that were protected from external corrosion. The EPA regulations for USTs became effective in September 1988 with 40 CFR parts 280 and 281. These regulations mandated corrosion protection and leak monitoring [4]. Although the regulations did not require secondary protection, they do state that secondary containment with interstitial monitoring would most likely result in fewer releases to the environment compared with protected single wall tanks with release detection.

The required corrosion protection can be obtained in several ways: corrosion resistant coating, cathodic protection or by construction with composite. The regulations do not stipulate that secondary protection is required. Some states, however, require secondary protection and interstitial monitoring for tanks used in underground storage of liquids. California, Kansas and Maine are three such states but the list goes on. Some states also require double wall piping for UST systems.

The specific construction techniques allowed by the regulations to prevent galvanic corrosion are:
(1) fiberglass reinforced plastic, (2) coated and cathodically protected steel, and (3) steel with FRP composite. Other methods of construction and/or use of other materials is allowed, if it is determined that no less protection for the environment and human health will occur as a result of their use. The purpose of this provision was to allow for development and use of new techniques and technologies as well as to allow for design variations for specific site conditions.

Existing USTs are included in the new regulations, though most are not equipped with any release prctection or detection features. The new regulations, nevertheless, require existing USTs to comply with corrosion prevention and failure detection provisions or be closed. The owners of these USTs are given 10 years to comply with regulations commencing September 1988.

Most concern about UST corrosion has been from the view of external corrosion. However, internal corrosion could very well become the major corrosion problem with the reduction of external corrosion by the newly required corrosion protection techniques. Internal corrosion is caused by the reaction of oxygen and water in the stored product with the internal metal surface of the structure.

As more corrosion susceptible internal areas are discovered, new methods for preventing corrosion of internal surfaces are developed. One novel method uses a non-corrosive protective coating or lining of the inside surface. The use of FRP for tank construction does away with the requirement for corrosion protection. However, such USTs are more sensitive to failure because they have less structural integrity compared to steel, additionally they are susceptible to deterioration caused by the product stored, especially alcohol. Indeed, the liquids of most concern for non-compatibility are the various alcohol blend fuels. The standard FRP tank can withstand alcohol blend fuels with up to 10 percent alcohol. A special resin must be used for FRP tanks that store blended fuels with more than 10 percent alcohol content.

Present concerns are focused on determining the number and location of leaking USTs and dealing with these leaks. In order to prevent adding to the existing problem new management practices must include new materials, monitoring methods and leak detection for all new installations of USTs.

CHAPTER 3

ENVIRONMENTAL AND ECONOMIC IMPACT

Tanks were typically placed under ground to store liquids that were hazardous because of their flammability. Aesthetics and space saving were added benefits of the underground storage tank. Because most tanks were installed underground without afterthought, little if any consideration was given to the consequences of any leakage that might occur.

With the discovery of leaking USTs came the realization that major environmental and economic impacts would ensue. In 1987, this realization came only too soon with the discovery of gasoline odors coming from the tap water in a farm house in Mount Sterling, Ohio and a gasoline contaminated water supply in Northwood, New Hampshire. In both of these cases, contamination of the ground water came from long forgotten USTs.

Nationwide there are numerous documented cases of drinking water wells that have been threatened or destroyed by leaking UST systems. Without knowing the exact numbers of leaking USTs, one can only speculate on the ultimate economic and environmental impact of the problem.

However, by extrapolating known data, a prediction of impacts will be attempted.

Numbers of Leaking USTs

It can be assumed fairly reasonably that one-fourth of the existing USTs are leaking, based on surveys by state, local and industrial sources from Florida to California [4]. Some industry sources estimate less than three percent while others claim leaks could be as high as 50 percent in some areas. Leak tightness tests support an average of 25 percent. Therefore, of the 2 million EPA regulated USTs, 500,000 tanks are probably leaking to some degree.

One study of a 1987 EPA "Causes of Release" document [4] shows that 10 to 13 percent of the tanks 12 to 13 years old were non-tight. In another study, of the tanks actually found to be leaking, 42 percent of the leakers were 14 to 20 years old, and 30 percent of the leakers were 10 to 15 years old. All of the tanks leaking were constructed of bare steel. This would indicate that the critical age in an unprotected steel tank is the period between 10 and 20 years when failure due to corrosion is most likely to occur.

Of the 750,000 sites regulated, the EPA has documentation that over 100,000 of these sites have had releases from the USTs located there. Estimates show that about 75 percent of the existing UST systems are without corrosion protection. With this basis, the EPA estimates that as many as 210,000 sites may be contaminated by leaking UST systems [4].

<u>What About the Millions of Unregulated USTs?</u>

The above leak estimates are associated with regulated USTs. As indicated above, the EPA estimates 2.7 million unregulated heating oil USTs and 0.4 million unregulated motor fuel USTs. In 1984, there were 425 reported releases <u>nationally</u> from these unregulated USTs. In 1985 and 1986 there were 2,032 releases reported from but <u>three states</u> (Maine, Maryland and New York). The EPA surmises that 95 percent of the unregulated USTs are constructed of bare steel and lack corrosion protection, that most residential heating oil USTs are made of thinner steel than regulated tanks and one-third to one-half of the unregulated USTs are over 16 years old. Consequently, there is a <u>tremendous potential</u> for unregulated tank leakage with concomitant negative impact to the environment and human health.

In any event, considering just the regulated UST population, the number of sites needing significant cleanup is expected to be in the tens of thousands nationwide. The unregulated USTs may prove to be as devastating to the environment as the regulated group. Careless past UST management practices must be changed and modified with real alacrity and concern for more than just financial gain.

Contamination Profile

How much gasoline does it take to contaminate water so that it is no longer suitable for consumption? As previously noted, a leak of one and one half cups of gasoline per hour can render one million gallons of water per day unsuitable for consumption [18]. Another way to look at it is that one gallon of gasoline can render 1 million gallons of water unsuitable for consumption [20]. Since such small amounts ruin the water supply it is obvious that once gasoline reaches ground water there will be major remediation expense. With ground water supplying some 50 percent of the drinking water for the United States population nationwide the potential for usable, and/or consumable drinking water shortages is quite real. Over 25 states claim that the number one threat to their ground water supply is leaking USTs. The EPA estimates that 11 million gallons of gasoline seep into the soil each year [9], and while certainly not all of those million gallons of gasoline leak into the ground water, a large percent will eventually percolate into water tables each year!

The potential environmental impact associated with 11 million gallons of spilled gasoline can be more easily understood if compared to the 11 million gallons of oil spilled in Alaska by Exxon's oil tanker, Valdez. There are of course some major differences, since the EPA estimate is an annual spill while the Valdez was a one-time incident. Another variance is that the estimated 11 millon gallons of leaking gasoline is not concentrated in one area, but dispersed into the many sites where USTs are located. Arguably gasoline leaks over many areas dilutes the impact, therefore, less of a problem exists than if it were all leaked into one area. The dispersion of this amount over many areas, however, could be even more devastating because of its potential to contaminate ground water at many different areas throughout the nation. The EPA estimates that even with the new regulations, 62,000 private and 4,700 public wells will be contaminated with petroleum products over the next 30 years [18].

Another concern associated with leaking USTs is the short term and long term health effects on both humans and animals in the ecosystem. Petroleum, with its 300 component chemicals, is linked with diseases such as cancer and anemia. It also causes liver problems, spots on the brain (that cause symptoms associated with Parkinson's disease and multiple sclerosis) and eye and skin irritation. The carcinogenic properties of the petroleum components benzene, xylene and toluene are well documented. Benzene is the most sinister for it can not be detected by smell or taste until it exceeds the drinking standard level in water. All three chemicals have long been used as replacements for lead in gasoline since it was banned so that octane levels could be maintained. Furthermore, these three chemicals, unlike other components of gasoline, are partially soluble in water, thus creating far more complex treatment methods for gasoline contaminated water.

The impact on the environment, however, is not limited to ground water pollution. Air pollution caused by volatile substances in gasoline is a serious problem, especially in parts of the nation where smog levels are already high (Southern Californian Basin, Denver, Colorado and the surrounding county). Soil contamination caused by leaking USTs is another problem that can effect the food chain from plants to animals to humans. Finally gasoline and the associated vapor/fumes from leaking USTs storing gasoline can collect in sewers, basements or cellars eventually leading to explosions and fires. A recent and devastating example of this is the destruction in Guadalajara, Mexico. On April 24, 1992, explosions ripped through the city and, according to the Mexican attorney general, damaged 1,422 homes, 450 businesses, 600 vehicles and gouged trenches in five miles of streets. Over and beyond this tremendous physical was the human and economic costs. Estimates made indicate over 200 people were killed with over 65 million dollars worth of damage. And this in a country that already has a staggering debt problem. Petroleos Mexico (Pemex), the Mexico City based state oil company, has accepted responsibility for the gasoline leak into the sewer system and offered to provide $32.7 million to rebuild the 20 block area leveled in the explosions. The cause of this disaster was attributed to corrosion of an underground gasoline line, owned and operated by Pemex, which crossed the southeast part of the city and supplied one of the main storage and distribution plants with gasoline. Unquestionably our local American fire departments are (and should be) acutely interested in USTs and their location, size, material of construction, age, and contents. The recent disaster in Chicago with underground flooding might be nothing to an urban conflagration caused by a leaking UST.

Cost Overview for Leaking USTs

Damage caused by leaking product from USTs can be very costly. The factors affecting costs associated with leaking USTs systems can be broken down into three major areas of concern: (1) loss of UST use during corrective action, (2) liability costs associated with public health and environmental damage, and (3) remediation costs.

The first two cost areas, down time and law suits involve many variables such as location and proximity to population, ground water and use of USTs. Costs relative to these areas are site specific and could vary tremendously depending on litigation and changing times. As an example, in the above Guadalajara, Mexico incident, what price can be placed on 200 human lives? By the same token, had this unfortunate event occurred in a less populated area or at a time when people were at work or away from home, perhaps fewer lives would have been lost. However, it is not the aim of this paper to concentrate on these type costs, but rather actual tank replacement and remediation costs.

Cleanup or remediation of the leaked product from the contaminated site will be estimated based on actual costs from some specific sites that have been and are presently contaminated. The primary factors affecting costs in this area are the substance involved, the magnitude of release, the hydro-geology of the site, the environmental standards and criteria or objectives relative to the site remediation plan. A risk management overview, as more specifically detailed in the Underground Storage Tank

Guide [25], will also be given showing that remediation costs can be very high. Although, liability costs could exceed cleanup or remediation costs, (depending on circumstances as noted above) only cleanup costs will be addressed.

Cost Estimates

Perhaps up to $750 million is spent annually to clean up leaks from USTs [10]. Much of the money is provided by major oil companies trying to comply with environmental laws. The costs associated with remediation is exemplified by the following ground water contamination case. In Clarksburg, New Jersey, leaking gasoline from USTs had contaminated ground water at 12 feet below ground level. The gasoline spread over the surface of the ground water and eventually reached water wells that were used by residents of the area. When the drinking water was found contaminated by the plume of hydrocarbons, a cleanup was ordered by the New Jersey State Environmental Agency. The ground water is now being pumped through a process that removes the contaminants by using a separator, a filter, a granular activated carbon unit and an incinerator to burn the expelled gases. It is expected that clean up of the ground water at the Clarksburg site will take 5 years or more. The pumping to clean up the water began in Nov. of 1989. After about two years, 1000 gallons of gasoline has been extracted from about 2 million gallons of water. An air powered pump, instead of electricity or other power generating method that could produce a spark, is used to pump the water out of the ground to minimize the risk of explosion or fire due to the volatile gases in the water. These special precautions are one reason why costs can be high.

The compounds added to gasoline, and the required processes to remove them, add time to the water treatment procedure. These also cause costs for cleanup of gasoline contaminated ground water to be high. As noted in the Clarksburg case, treatment of gasoline contaminated ground water can easily take over 5 years; costs for the cleanup have already exceeded $350,000.

Risk management is a method of estimating costs that are unknown or undeterminable and then choosing between alternatives to manage these risks. In this paper only expected costs will be determined, management alternatives will not be addressed. One factor that cannot be determined with certainty is when or if a UST will leak. This uncertainty can be accounted for by using leak data associated with existing USTs and establishing probabil-ities of leaks according to the data. As an example, the data previously noted in this chapter shows that 10 to 13 percent of the existing USTs 12 to 13 years old experience leaks, and 42 percent of these USTs 14 to 20 years old experience leaks. Using this leak probability, expected leak costs can be calculated. The expected value of the uncertain outcomes can be calculated as the sum of the value of the costs times the probability of the occurrence. The result can then be used to determine what action is necessary in order to bring the risk to an acceptable level. Mathematically this process is expressed by equation 3.1 below.

(3.1) Expected Value = $\Sigma_{i=1}$(Val. of Outcome i)x(Prob. of i)

Here the probability that a tank 10 to 20 years old will leak is 0.115 (the average of 10% and 13%) times the number of tanks in the age category of 12 to 13 years old, plus 0.42 times the number of tanks in the age category of 14 to 20 years old. Estimates show that there are about 600,000 regulated tanks in the age category of 10 to 20 years. About 350,000 of these are in the 10 to 15 year category and about 250,000 in the 15 to 20 year category. Using these numbers, the Expected Value, or the number of tanks expected to leak is 142,250 USTs.

An estimate by the EPA breaks down costs associated with existing USTs by separating them into percentages. The EPA estimate is that cleanup of product from 85 percent of the leaking USTs will cost about $36,000, and for

10 percent the costs will be about $300,000, and for the remaining 5 percent the costs will be about $1 million. If these percentages are used on the above expected value of 145,250 USTs, in the age category of 10 to 20 years old, the costs associated with these leaking tanks would be: $4.4 billion for 85 percent at $36,000 each, $4.36 billion for 10 percent at $300,000 each, and $7.26 billion for 5 percent at $1 million each. The total cost is $16.2 billion for all three percent groups. If 25 percent of the estimated two million USTs are leaking or 500,000 USTs, and this number is multiplied using these percentages and estimated costs, the cost break down would be: $15 billion for the 85 percent at $36,000 each, $15 billion for the 10 percent at $300,000 each and $25 billion for the 5 percent at $1 million each. Overall cleanup costs would be $55 billion using this method of estimating. Once ground water is found to be contaminated hydrologists need to determine the volume and the area that the ground water encompasses, the direction of flow and the extent of the spread of the contaminant. After this a cleanup plan can be designed. Each site is different and costs vary. Another estimate [24] for cleanup and replacement costs of a 5000 to 7000 gallon UST is $120,000 to $265,000. The breakdown for these costs is as follows:

Table 3.1.--Cleanup and replacement costs for a 5000 to 7000 gallon UST

Cleanup and Replacement	Cost
Tank preparation and test	$1,000
Tank excavation	$1,000
Soil analysis	$10,000 to $20,000
Ground water analysis	$20,000 to $50,000
Contaminated soil removal and disposal	$5,000 to $20,000
Ground water cleanup	$20,000 to $100,000
Replacement tank (coated steel)	$50,000
Regrading	$3,000
Management	$10,000
Total	$120,000 to $265,000

A site of leaking USTs at East Setauket in Long Island, New York, is estimated to contain 1 million gallons of gasoline in an underground lake that is 7 feet deep in places. The cleanup costs associated with this site have already exceeded $10 million and the end is not in sight [18]. Fortunately, leaks of this magnitude are not common, although they do occur as previously discussed, but with the new regulations governing leak monitoring most leaks should be discovered before significant damage has occurred to either human health or the environment. The bottom line is that the longer un-protected tanks are under ground, the more leaks will occur. The quicker leaks are found, the lower the costs will be for remediation and liability.

Financial Responsibility Requirements

The new regulations found in the Code of Federal Regulations (CFR) 40 part 280 and 281 published October 26, 1988, require owners of USTs to be financially responsible for any costs associated with leaks from the "USTs systems" (The term "USTs systems" means any under ground storage tank and associated piping and valves).

At present the regulations require financial responsibility for all USTs containing petroleum products. Exempted tanks include USTs in the following categories:

1. USTs containing hazardous waste already covered by RCRA

2. USTs systems containing electrical equipment and hydraulic lifts

3. Waste water treatment USTs that are regulated by the Clean Water Act

4. USTs with capacity of less than 110 gallons and tanks holding a minimal concentration of regulated substances

5. USTs that serve as emergency backup, hold regulated substances for only a short time, and are expeditiously emptied after use

6. Field constructed tanks

7. USTs containing radioactive materials and USTs used a backup diesel tanks at nuclear facilities

8. Airport hydraulic fueling systems

9. Farm or residential tanks with capacity of less than 1,100 gallons used for storing motor fuel which is not for resale

10. Tanks for storing heating oil which is used on-site

11. Septic tanks

12. Certain pipeline systems, such as those regulated under the Natural Gas Pipeline Safety Act of 1968

13. Surface impoundments, pits, ponds or lagoons

14. Storm or waste water collection systems

15. Flow through process tanks

16. Liquid trap and other lines used in oil or gas production

17. Storage tanks on or above the floor of an underground area, such as a basement or tunnel

To be sure, this is a lengthy list and includes millions of tanks. However, these federal EPA exemptions may be denied by the state's environmental protection agencies. Many states in fact refuse to exempt tanks in some of the above categories. The state of Maine, for example, has gone so far as to not allow exemptions for underground storage tanks <u>of any kind</u>. The present law there governing USTs requires all new USTs to have secondary containment with interstitial monitoring. California <u>regulates</u> residential USTs which contain heating oil, greater than 1,100 gallons capacity. Wisconsin regulates all USTs. While some USTs are exempt from government imposed financial responsibility they are not exempt from third party liability suits or state charges for damage caused by leakage. For example, if a leak from an exempt UST is found, the owner of the property with the UST may still be liable for damages caused to adjoining property owners. Even if the UST was not known to exist. Or the state may impose penalties for leakage. Consider the poor owner of property in Potchoque, Long Island, New York who had an UST that leaked. The owner was required to pay $3,000 for removal and cleanup and $60,000 in follow-up monitoring costs [18].

Farmers and other property owners have an incentive to determine the status of any UST within their property. Realtors and financial lenders are requiring verification of the status of USTs prior to the sale of farm property [24]. The reasons for these more conservative requirements are easy to understand when banks and lending institutions are found liable for remediation costs if a borrower defaults on a loan. Typical of this is the case in Northwood, Ohio, where a bank loaned $73,000 in 1978 to a borrower to purchase about 3 acres of land. In 1989, the bank foreclosed on $62,700. The bank had the property checked by an environmental firm who found two 750 gallon capacity USTs which stored gasoline. Research revealed that the site had been used in the late 1920s as a gasoline station. The bank, now the title owner of property, by default, was required, by EPA regulations to remove the two tanks at a cost of $14,560.

Recently, the Bush Administration has eased the liability of banks for toxic pollution caused by business operations financed with their loans. This rule change, issued by the EPA in April of 1992 was intended to encourage uneasy lending institutions to offer more credit to commercial property buyers and spur the economy. The rule shifted the cleanup to provisions of the 1980 Comprehensive Environmetal Response, Compensation, and Liability Act (CERCLA), which is also called the Superfund law.

Requirements and Shortcomings of the Financial Responsibility Regulation (FRR)

Showing financial responsibility is not just a matter of finding an insurance company and paying a premium. Insurance for UST owners is hard to obtain. The requirements of FRR mandate one of two financial commitments. The first one is if you are a "Petroleum Marketer," you must have at least one million liability coverage for costs associated with leaks or spills of any USTs you own; if you are not a marketer then you need "only $500,000" to cover losses due to leaks or spills associated with your USTs.[1]

This required coverage can be evidenced by net worth, insurance, bonds, sureties or other methods, however, these minimum financial responsibility levels do not limit the total UST owner liability. Third party suits could well endanger the very existence of even large corporations. Currently, most companies cover the FRR with the following:

1. Net worth greater than required by EPA minimum of $10,000,000

2. Insurance coverage

[1]These requirements are listed in the Federal Register of October 26, 1988.

3. Guarantee from a corporation, relative or other firm with which you have a business relationship

4. Surety bond

5. Letter of credit

6. State funds, if available

7. Use state approved methods if available

8. Set up a trust

Most states do not have programs to provide funding for financial responsibility and/or many of the above methods are not available. Large corporations can get by using net worth to sales by FRR. Small businesses with less than $10 million net worth use insurance primarily to show financial responsibility. Unfortunately, however, insurance is not always available. Private insurers are very selective in the USTs they will cover. Coverage for tanks over 20 years old is extremely hard to obtain. Even if an UST is less than 20 years old certain conditions will be required to obtain coverage. These include testing the UST for tightness, installing leak detection equipment or providing corrosion protection. Such "additions" can be expensive and may well exceed the cost of tank replacement. Obviously, when this is the case replacement then becomes the most sensible alternative.

Financial Responsibility Deadlines

The deadlines for demonstrating financial responsibility are likewise broken down into petroleum marketers and non-marketers by number of tanks and net worth of non-marketers.[2] The following table is an updated overview of this data.

Table 3.2.--Financial Responsibility Deadlines

Deadline	Marketer	Non-Marketer	Local Government
Jan. 89	1000 or more tanks	Net worth >$20 million	NA
Oct. 89	100-999 tank	NA	NA
April 91	13-99 tanks	NA	NA
Dec. 93	1-12 tanks	Net worth >$20 million	To be determined

These deadlines were changed by the EPA from those originally established because it was apparent that they could not be met. The original deadline for local governments, marketers with 1-12 tanks and on marketers with less than $20 million net worth was October 1990. This deadline was changed to allow insurers to offer more policies and to revisit the requirement for local governments to show financial responsibility. Presently, insur-

[2]Reference 4 has a detailed break down of the deadlines.

ance is limited and small businesses are finding it difficult to obtain coverage and meet the EPA Financial Responsibility deadline [7]. Local government compliance has been deferred. Economics seem, for the moment, to have overcome environmental concern.

CHAPTER 4

DETAILED STATISTICS ON IMPACTS OF USTs

Today there are many unanswered questions regarding USTs due impart to the inadequate record keeping practices of the past. Some of the more pressing of these questions concern leaks, costs, and environmental damages.

This chapter will concentrate on estimating the statistics associated with USTs such as size, contents stored, population and construction material. It will also address the number of leaking USTs, location of USTs, the length of time USTs have been in the ground. Major emphasis will be placed on the economic and environmental aspects associated with the UST data collected.

With this in mind, the following issues will be addressed:

1. Where are USTs located and what is the population density?

2. What was the dominant material used in UST construction in the past and what is being used today?

3. How many UST are leaking and what are the environmental and economic consequences of those leaks?

4. How much will it cost to meet the new UST regulations?

The actual number of reported and EPA registered USTs is less than 2 million, presently 1,788,505. This number and actual collected data will be used in all estimates in this chapter. For example, if actual data collected on a representative survey of 100 tanks show that 10 tanks leaked, then an estimate of 10 percent of existing tanks of the same material and age group would be currently estimated. In the case of 1,788,505 UST, if all were of the same material and age group as the tanks surveyed, then the estimate for existing conditions would be 178,850 leaking UST. This technique contrasts with using existing approximations for the number of leaking USTs based solely on incomplete and partially estimated data. Necessary approximations will be made if data simply does not exist, but they will be highlighted accordingly. The information found on USTs will be separated into age groups. These age groups will show different categories such as material of construction and products stored. One category discussed is referred to as the "Unknown Category." The unknown category includes tanks that are known to exist but specific data such as contents stored, age, and tank material are not known.

Petroleum USTs

Figure 4.1 shows an estimate of the number of USTs storing petroleum products by age groups.

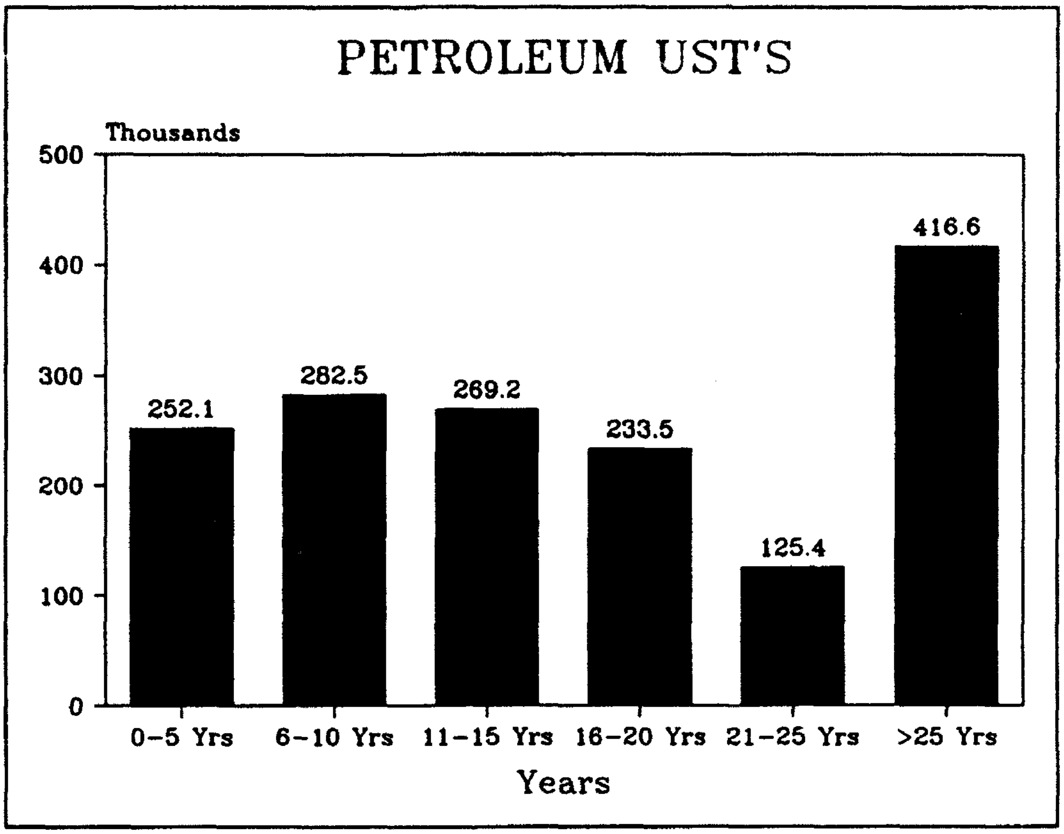


Figure 4.1. Number of USTs storing petroleum products

The total number of UST used to store petroleum products is estimated to be 1,579,300. The majority of the tanks storing petroleum products have been in the ground for well over 10 years (about 1,044,700 tanks or 66 percent). Close to 26 percent of the tanks are over 25 years old. Their condition cannot be very good. Figure 4.2 shows the estimated number of USTs storing non-petroleum products with the estimated number of USTs storing petroleum products. Clearly the majority of USTs are used to store petroleum products. In fact 90 percent of USTs in all age groups, except the over 25 year age group, are used for petroleum storage. In the over 25 year age group only 80 percent are shown to be used for petroleum storage. The reason for this marked difference is the unknown category. The number of tanks over 25 years old is estimated at 517,900 but records do not show the use for many of these tanks. In other words, it is not known what some USTs (approximately 43,000) over the age of 25 years actually store. This should not come as a great surprise considering the scanty record keeping practices prior to the implementation of the 1988 UST regulations. However, it is highly likely that the majority of the USTs, in the unknown category, are used to store petroleum products. But, with or without the inclusion of the unknown category the data shows that the large majority of regulated USTs are used to store petroleum products. It can, therefore, be predicted that, for the most part, petroleum products will be the agent of interest when coping with the population of regulated leaking USTs.

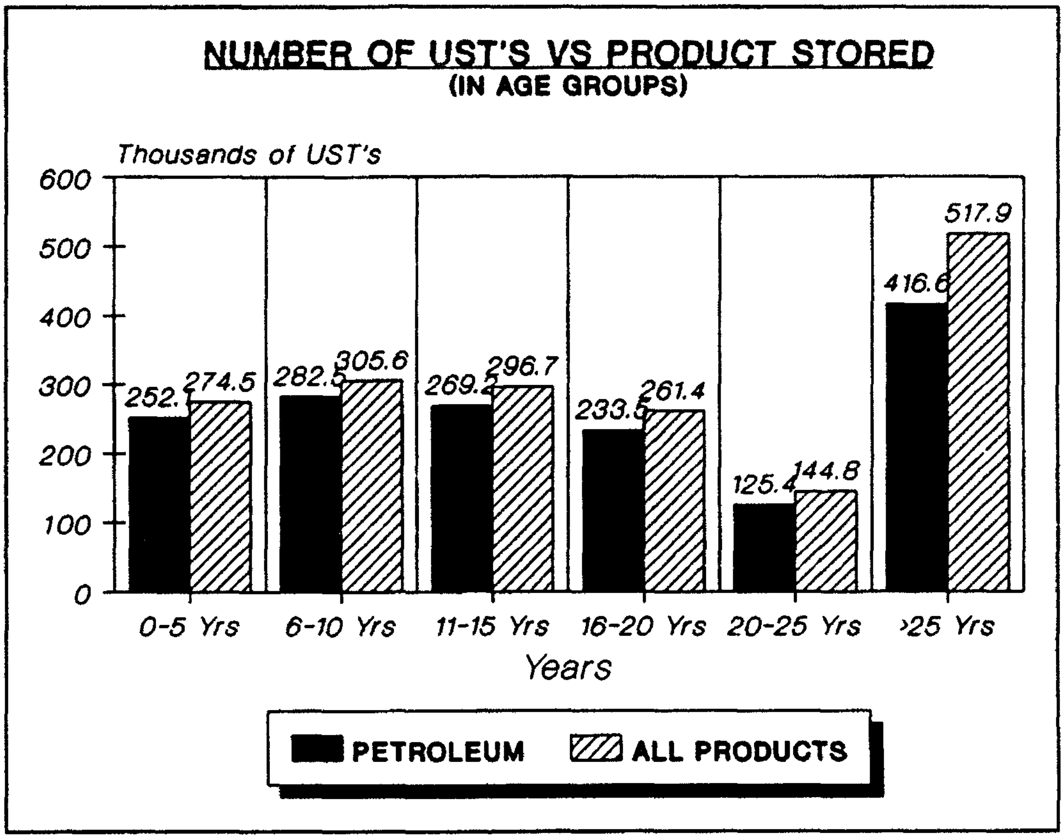


Figure 4.2. Number of USTs Versus Product Stored

UST Material

As previously discussed corrosion is the major cause of UST leakage. In order to assess how many UST are leaking, because of corrosion, it must first be determined how many existing USTs are made of a material that is susceptible to corrosion. Figure 4.3 shows estimates according to age groups, of underground storage tanks made of steel.

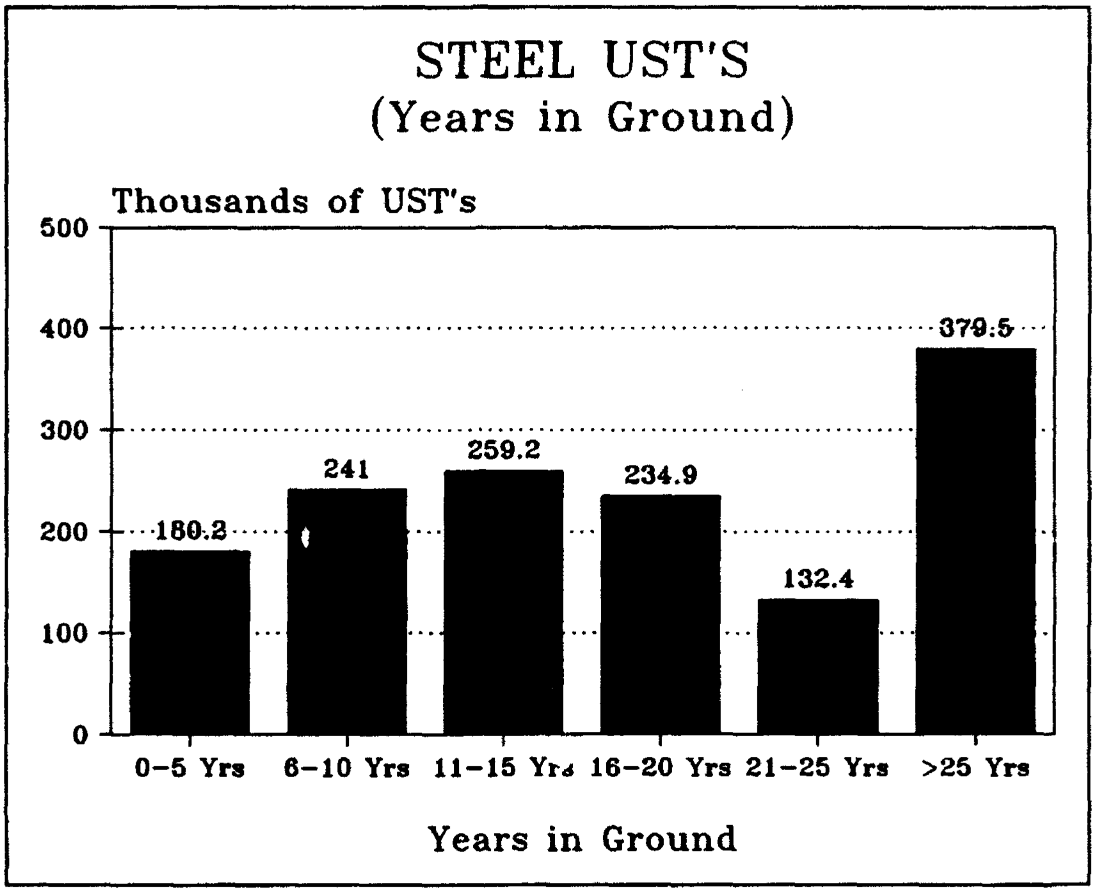
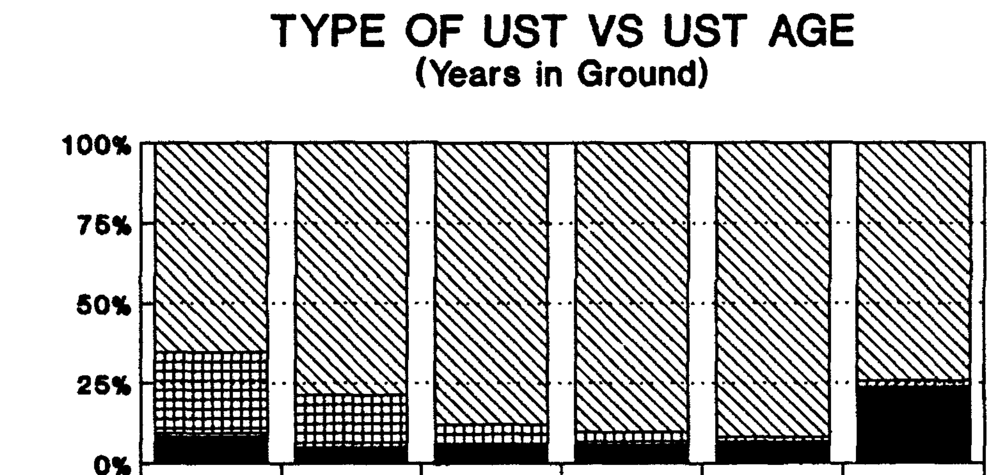


Figure 4.3. Steel USTs

There are an estimated 1,427,200 UST made of steel. This represents almost 80 percent of the UST population. Most USTs are over 10 years old (about 1,060,000 out of 1,427,200 or 74%). Of more interest, is the number of USTs in the over 25 year age group, where it is estimated that 379,472 tanks are made of steel or about 27 percent of the total steel UST population. The concern here is that most of the tanks installed over 25 years ago were installed <u>without corrosion protection</u>. The probability that the majority of older tanks are leaking is very high.

As shown above in figure 4.3, the steel UST population over 20 years old is significant. In figure 4.4 below a comparison of USTs made of different materials to the total UST population is given.



	0-5 Yrs	6-10 Yrs	11-15 Yrs	16-20 Yrs	21-25 Yrs	>25 Yrs
Steel	180000	241000	259200	234900	132400	379500
FRP	70000	50000	19600	9900	1900	10000
Concrete	2500	2100	1600	1400	560	4200
Unknown	23200	13200	15000	14000	9300	118000

Figure 4.4. Type of UST versus UST age

Here it is shown, as stated above, steel USTs make up the large majority of the total UST population 1,427,000. Of the total steel USTs, 511,900 are estimated to be over 20 years old. This represents more than 28 percent of the total UST population. If one applies the 25 percent leakage rate arrived at in chapter 3 to these aged unprotected steel tanks, the result will quite likely be a gross under-estimate of the number of leaking USTs in the age groups of 16 to 20 years and 21 to 25 years old. The actual leak history of USTs, however, will not be known until the actions required by regulations are met.

It will be shown later in this chapter under "Number of Leaking USTs" how many steel USTs are estimated to be leaking.

UST Regulations

Tables 4.1 and 4.2 below present an overview of the current regulations regarding new and existing USTs. All newly installed USTs must meet new tank requirements of table 4.1. Existing UST are allowed a phase-in period of ten years, commencing Dec. 22, 1988 (see table 4.2). The leak detection requirements, for existing tanks, also includes a phase-in based on tank age. For an existing UST, the regulations allow for one of two actions to be implemented: either meet the monthly monitoring as required by the new tank requirements <u>or</u> monthly inventory control and tank tightness testing.

The monthly monitoring allows a phase-in of requirements depending on tank age. If a tank is older than 25 years, it must have met the monthly monitoring requirement as of Dec. 22, 1988. The latest implemen-tation date for this method is Dec. 22, 1993 for tanks less than 10 years old. If the monthly inventory control method is used for leak detection then the latest implem-entation date for tank upgrade is Dec. 22, 1998. For tanks over 25 years old, the "monthly inventory control with tank tightness testing" requirement must have been implemented by Dec. 22, 1988 and the "monthly monitoring" requirement must have been implemented by Dec. 22, 1988. For other age groups, the required actions are as shown in the table. <u>All existing USTs, over 15 years old, should already have a leak detection method in place.</u>

Regulations also require that leaking USTs be reported to the EPA for record purposes. It is unexplained why there remains such a large number of regulated USTs over 25 years old in the "unknown" category for leaks; especially with the most indulgent method, monthly monitoring, required since Dec. 22, 1989 for those USTs in the over 25 year age group.

Table 4.1.--New tank requirements

Requirement	Action	Time Deadline
Corrosion protection	1. Coated steel with cathodic protection 2. FRP or 3. Steel clad with FRP	Required with new installation
Leak detection	Monthly monitoring by: 1. Automatic gaging or 2. Vapor monitoring or 3. Interstitial monitoring or 4. Groundwater monitoring or 5. Other EPA approved method 6. Montly inventory control can be used with 5 year tightness test instead of any one of the above	Required with new installation Monthly inventory control with 5 year test good up to 10 years, then monthly monitoring required.
Spill and overflow devices	Catch basins and automatic shutoff devices or overfill alarms or ball float valve	Required with new installation

Table 4.2.--Existing tank requirements

Requirement	Action	Time Deadline
Corrosion protection	Cathodic protection or interior lining (with regular inspection) or both	Dec. 22, 1998
Leak detection	Same as new tank or: monthly inventory control and tank tightness test-- 1. If corrosion protection and spill/overflow prevention (CP & SP) installed by Dec. 22, 1988 then: a) Tank tightness test (TT) every 5 yrs. and monthly monitoring (MM) by Dec. 1988 2. If CP & SP installed after Dec. 1988 then: a) TT every 5 yrs. and MM 10 yrs. after upgrade 3. If no CP or SP then: a) Annual TT and replace or upgrade by Dec. 1998	If meeting new tank action: 1. If tank >25 yrs. old by Dec. 22, 1988 2. If tank 20-25 yrs. old by Dec. 22, 1990 3. If tank 15-19 yrs. old by Dec. 22, 1991 4. If tank 10-14 yrs. old Dec. 22, 1992 5. If tank <10 yrs. by Dec. 22, 1993
Spill and overflow devices	Same as new tank in table 4.1	By Dec. 22, 1998

Some deadlines have already passed. For those tank owners who have not met the deadlines, there are stiff penalties for noncompliance; anywhere from $10,000 to $25,000 can be assessed per violation as shown in table 4.3.

Table 4.3.--Civil penalties

Violation	Penalty
Non-compliance of admin. order	$25,000
Notification violation	$10,000
All other requirements	$10,000

With the exception of the "Notification Violation" all penalties can be compounded on a per tank per day basis. There are, however, no criminal penalties associated with these regulations.

Upgrading Expenses

Table 4.4 below shows expenses that might be expected when implementing the new regulations to bring existing UST into compliance. Even the least expensive leak detection method, the tank tightness test, is no bargain. It must include the labor intensive monthly inventory control by manual gauging costing $50 to $1000 per tank or the automatic tank gauging costs of $10,000 to $17,300. The EPA conducted numerous surveys and requested considerable input from enterprises most impacted by UST regulations, before actually implementing them. The intent was not only to consider the financial aspects of implementing UST regulations, but also the enforceability of the regulations. As noted above in table 4.3, other EPA approved methods different than those listed in table 4.4 are also allowed. This allowance was intentional so as to leave the door open for new ideas and or technologies that might provide less expensive alternatives while providing an adequate UST leak detection method.

Table 4.4.--Leak detection costs

Leak Detection Method	Costs
Ground water monitoring	$2200 to $14,000; 100 ft well + $100-$200/yr oper.
Vapor monitoring	$2450 to $8200
Secondary containment w/ interstitial monitoring	$25000 to $46000 for 3 10K gal. tanks
Automatic tank gauging	$10000 to $17300
Tank tightness testing w/ inventory control	$250 to $1000 per tank
Manual tank gauging	$200 to $1000 per tank
Leak detection for suction pipe	Approx. $250 to $10000+
Leak detection for pressurized pipe	Approx. $50 to $10000+

Numbers of Leaking UST

The major environmental concern associated with USTs is the population of existing unprotected, old steel tanks. As older tanks are replaced with newer models the incidence of leaks will decrease, but there remains a large number of existing USTs that have been in the ground over 10 years.

Studies discussed in chapter 3, have shown that the critical age for leaks to develop in unprotected steel tanks, is between 10 and 20 years. With 42 percent of the UST in the 14 to 20 year age group leaking, it is undeniable that an even greater percentage of the unprotected steel tanks which have been in the ground for over 20 years are leaking. Without complete and accurate data, it is impossible to know the precise numbers of leaking tanks in any age group. However, a representative, small scale, sample survey of unprotected steel tanks in the over 20 year group was obtained. The results are shown in table 4.5 below. The areas covered include those of the East and of the West Coast of the United States. The results of this survey show that over 95 percent of steel tanks past 20 years old leaked. Even the steel tanks that were installed with a protective tar coating leaked.

Table 4.5.--Sample survey of leaking UST over 20 years old

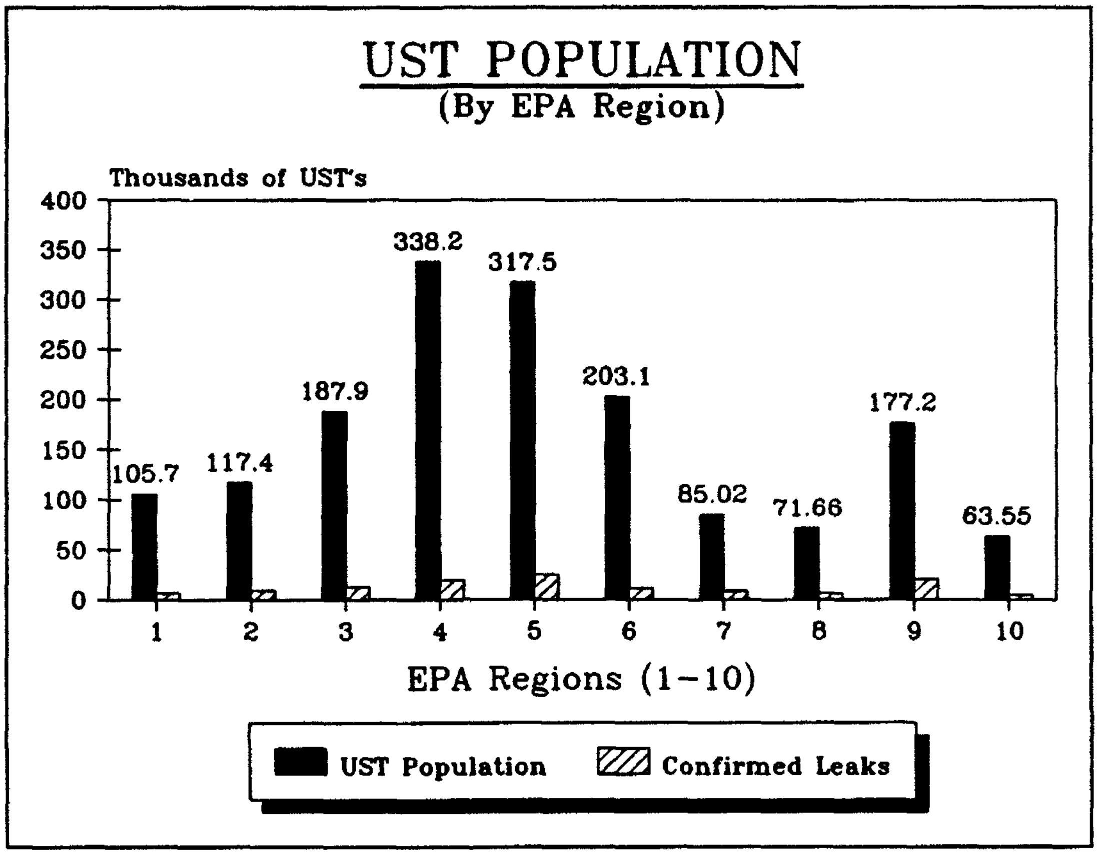
Location of Ust	Number of UST	Number Tested	Number Leaked	Percent Leaked
E Coast	556	167	159	95
W Coast	1399	566	547	96

Although not shown on the survey, there are many USTs still in use, that were placed underground in the 1940s, especially the USTs used for military fuel storage. Some records show USTs placed as far back as 1914. The sample survey represents only a fraction of the UST population. However, it is reasonably representative of both coasts. If the survey findings are expanded to include all existing, regulated UST's, then the number of leaking USTs must be much larger than the accepted 25 percent.

The EPA's most recent compilation of confirmed releases nation wide is shown in figure 4.5. This data shows that of 1,788,505 USTs a total of 127,195 have been reported to have leaked.

Using the results of the survey shown in table 4.5, if 95 percent of the USTs over 20 years old are leaking then there would be 486,305 USTs releasing product into the environment from this age group alone. (This compares to an estimate of 448,300 total leaking USTs based on an

Figure 4.5. UST Population by EPA Region



approximation that 25 percent of the existing USTs are leaking).

Because exact data is not available the leak estimates, for steel tanks, in the 0 to 20 year age group, will be approximated.

In the 10 to 20 year age group, as figure 4.4 reveals, there are an estimated 494,100 USTs made of steel. Of these steel tanks, in the 10 to 20 year age group, it is reported that, as of April 1991, 122,473 have no corrosion protection, 213,766 are in the unknown category (not known if any corrosion protection is provided) and 42,492 are known to have cathodic or lining corrosion protection [4]. Since the critical age for unprotected steel USTs is between 10 and 20 years, a 25 percent leakage approximation will be used for the steel USTs in the 10 to 20 year age group. This may be conservative but considering the age range and the unknown status of corrosion protection data, 25 percent is probably a good estimate. By using the 25 percent leakage estimate for steel USTs in the 10 to 20 year age group, an estimated 123,525 USTs are leaking in this group. The remaining USTs in the 0 to 10 year age group are mostly USTs that have corrosion protection or are made of materials such as FRP that are corrosion resistant. There are, however, an estimated 102,022 USTs in this category that are without corrosion protection. This is out of a total of 421,200 USTs in this age group or 24 percent. Because of the relatively high number of unprotected USTs in this age group and the potential for damage of the UST during installation a 5 percent (approximation) leakage rate for these USTs is used. This gives a total number of leaking USTs in the 0 to 10 year age group as 21,060. Based on these estimates the total number of leaking steel USTs nation wide would be 630,890.

These estimates are only for steel USTs and do not include USTs made of concrete, FRP or any other material. Non steel USTs make up about 20 percent of the UST population or about 366,077 USTs (see figure 4.4), and do count as part of the overall number of leaking UST's. The following is an approximation for the number of leaking USTs that are made of material other than steel. Of the 366,077 USTs in the non steel category, 146,934 are in the unknown category and may well be made of steel. For this reason and because these USTs include non steel USTs in the age group from 0 to over 25 years old, a 25 percent leak criteria will be used. This gives an estimate of an additional 91,519 leaking USTs for a total of 722,700 (rounded of to the nearest hundred) leaking USTs nation wide. Table 4.6 is a summary of these leak estimates.

Table 4.6.--Estimated Number of Leaking Regulated USTs

Tank Material	0-10 years	10-20 years	Over 20 years
Steel	21,100	123,500	486,300
Non Steel	40,200	15,400	36,200
Total	61,300	138,900	522,500

To the totals of table 4.6 must be added the number of unregulated USTs that are leaking. They have the potential to cause the same economic and environmental havoc as the regulated USTs.

Figure 4.6 gives a comparison of steel and total USTs with a cumulative estimate of leaks by age group based on a <u>25 percent across the board</u> leak approximation.

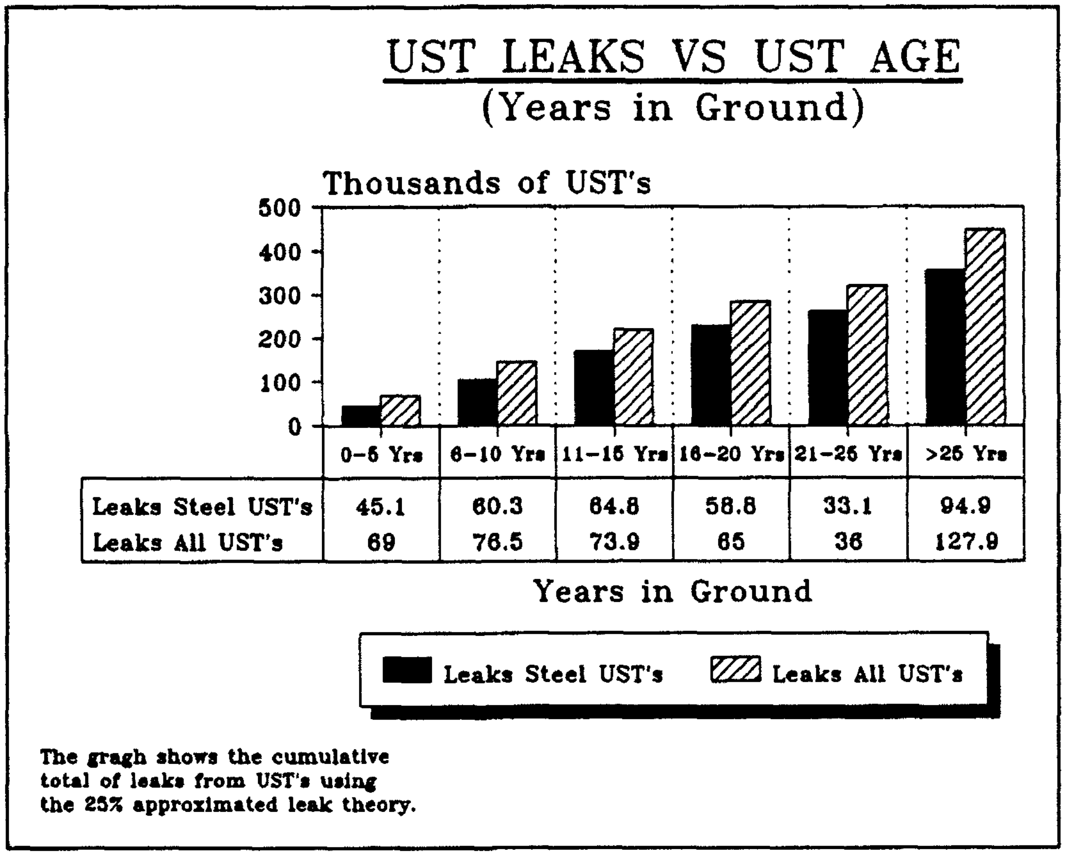


Figure 4.6. UST leaks versus UST Age

In figure 4.6 the age groups are broken down into 5 year increments and as can be seen the age group with the most leaking USTs is the over 25 year age group with 127,900 estimated to be leaking. When added to the 20 to 25 year age group the total is 163,900. This number when compared with the 95 percent sample survey results (table 4.6) of 522,500 leaking USTs, over 20 years old, is much smaller. The 0 to 10 year group of figure 4.6 shows an estimate of 145,500 leaking USTs. This number when compared to the table 4.6 estimate of 61,300 is much larger. Figure 4.7 is a graphic representation of the above comparison, between the survey sample data and the across the board 25 percent estimated leakage. As shown, the survey sample data (leaks steel USTs plus Leaks non steel USTs) shows a dramatic increase of estimated leaking USTs with UST age. This increased leakage with age would be expected for underground storage tanks regardless of material. The 25 percent across the board estimate remains relatively constant with age. This would imply that age has no effect on tank leak status when in fact age plays a significant role in the integrity of an underground storage tank, especially unprotected steel tanks as discussed in chapter 3.

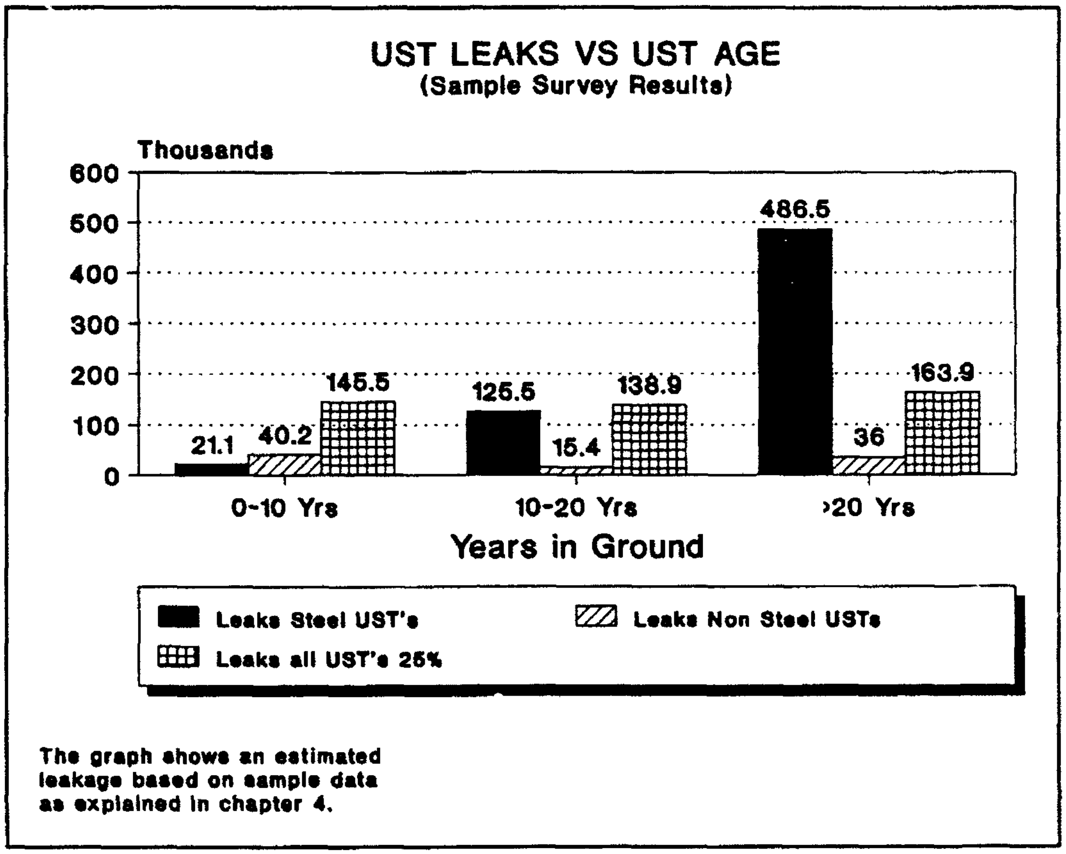


Figure 4.7. UST Leak Versus UST Age Sample Survey Result

UST Location

Table 4.7 below shows the UST population density by state in the range of less than 10,000 tanks to over 100,000 tanks. If the continental United States is divided roughly in half geographically by the Mississippi River, twenty six states will be in the eastern portion and 22 in the western portion. Including Alaska and Hawaii with the western group gives an approximate equal split mathematically. Those states in EPA regions one through five are in the eastern portion and those in regions 6 through ten are in the western portion. With this separation one can better understand the concentration of USTs and, therefore, the potential problems nation wide.

Only two states have estimates of USTs over 100,000: California with an estimate of 148,311 USTs and Texas with an estimated 132,954 USTs. Twelve states and 3 territories have estimates of less than 10,000 USTs. Sixteen states, the largest number, have an estimated number of USTs in the 25,000 to 50,000 range. With the exception of Washington, all of these states are located in the eastern portion of the nation. Nine states have an estimated number of USTs in the 50,000 to 100,000 range and all of these states are also in the eastern portion of the nation. With the exception of California, Texas and Washington, no state west of Oklahoma has more than an estimated 25,000 USTs. Washington has an estimated 30,909 USTs. Consequently, the eastern portion of the nation contains 70 percent of the country's regulated USTs: 1,257,424 out of the reported 1,788,505.

Of the 22 states in the western portion of the nation, California and Texas have 53 percent of the USTs or 281,265 of 531,081 USTs.

Table 4.7.--UST population density table (per state)

No. of USTs	State Name (Abbreviated)	No. of States and Territories
<10,000	NH, RI, VT, DC, DE, WY, ND SD, NV, HA, ID, AK, GUAM, VIRGIN IS, PUERTO RICO	15
10,000 to 25,000	WV, MS, AR, NM, IA, KS, NB CO, MT, UT, AZ, OR	12
25,000 to 50,000	CT, ME, MA, NJ, MD, GA, TN, KY, AL, SC, IN, WA, LA, OK, MO, MINN	16
50,000 to 100,000	NY, VA, PA, NC, FL, OH, WI, IL, MICH	9
>100,000	TEXAS & CALIFORNIA	2

Fate of the USTs

What happens to USTs as they go through the required process to meet the new regulations? The answer to this question is that USTs will end up falling into one of four categories: (1) disposed of and replaced with new USTs designed to meet the latest UST criteria, (2) disposed of and not replaced (Tank Closed), (3) repaired and/or updated to meet new UST criteria and, (4) disposed of and replaced with an above ground storage tank.

Figure 4.8 shows the result of a survey taken on a small number of UST owners in different parts of the nation. The data shows that many USTs fall into category 2 and just simply are not replaced. In this case the tank is closed by following tank closure procedures as promulgated by the EPA or other governing authority. A small percentage are repaired in place and new leak testing, monitoring and corrosion protection is incorporated in the repair contract. Others are replaced with new USTs that

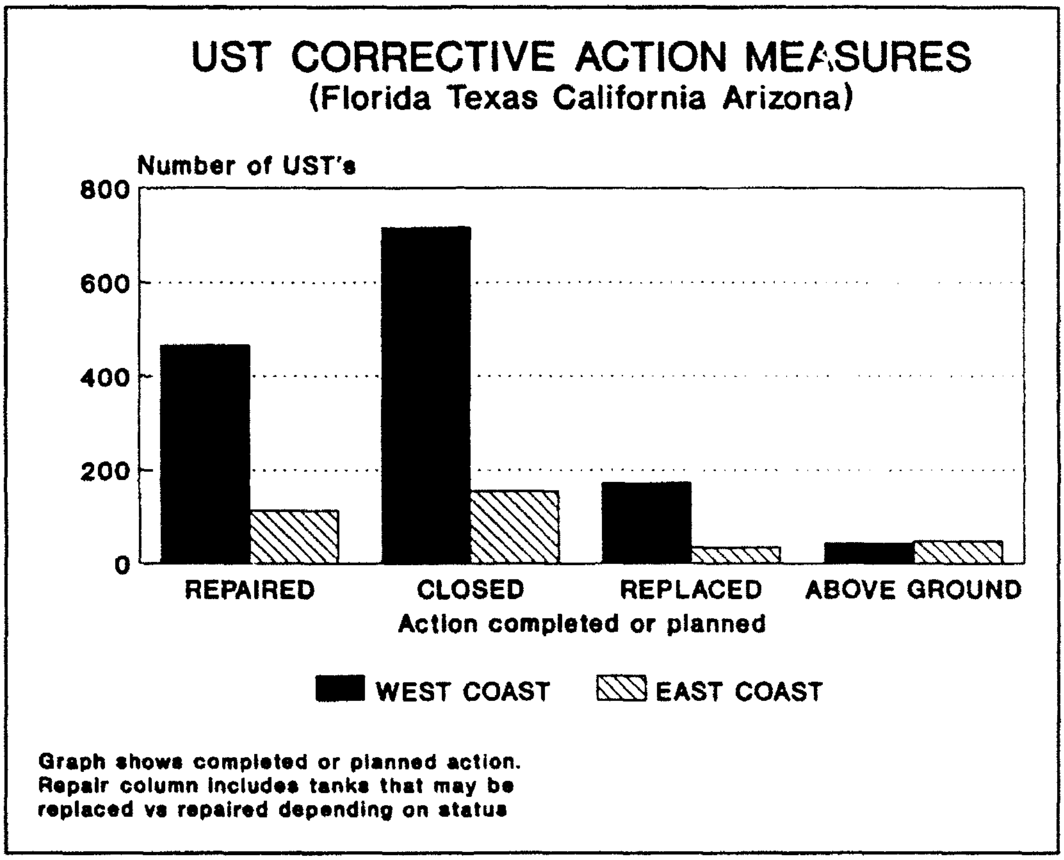


Figure 4.8. UST Corrective Action Measures

meet the latest EPA and/or state requirements for USTs. And a very small percentage are replaced with above ground storage tanks. If an UST falls into category 1 and is replaced with a new UST the most common choice is a double walled FRP tank. The reasons for choosing this type of tank are many, however, that subject is beyond the scope of this paper.

Above Ground Storage Tank

As noted above, some underground storage tanks are replaced with aboveground storage tanks (ASTs). Is this a solution to the environmental problems associated with USTs? Obviously if all USTs were replaced with ASTs there would not be any more tanks leaking under ground. With all the regulations governing USTs, leak detection requirements, insurance requirements and other costs it would seem that replacing USTs with ASTs is the most logical thing to do. However, ASTs come with their own set of problems and in many cases an AST is not an appropriate choice for petroleum or hazardous liquid storage. In order to make an informed decision on whether to put in an AST, a wide range of factors should be considered. Table 4.8 shows some advantages and disadvantages between USTs and ASTs. And, although this list gives numerous advantages and disadvantages careful consideration must be give to the specific site where tank storage is needed. Case in point, an airport. If tank storage is required at an airport just having a tank above ground presents a hazard to the daily operations. If the tank additionally

Table 4.8--Advantages and Disadvantages of USTs and ASTs

TANK	ADVANTAGES	DISADVANTAGES
AST	1. Less expensive liability insurance 2. Less regulation 3. More designs to choose from 4. Gravity flow from tank 5. Large volume efficiency	1. Fire hazard 2. Spills from over flow due to pumping 3. Permits 4. Dikes & spill control devices 5. Temperature fluctuations 6. Tank supports
UST	1. Land use 2. Esthetics 3. Gravity flow to tank 4. Constant temperature 5. Structural support	1. Liability insurance costs & availability 2. Regulations 3. Pumping required from tank 4. High volume inefficiency 5. Corrosion protection

contained a flammable liquid the hazard would be even greater. Therefore, use of ASTs at certain sites would not be practical even if the advantages far out number the disadvantages.

Presently ASTs are not regulated to the degree that USTs are regulated. The National Fire Protection Association has the most extensive regulations governing ASTs. These regulations typically involve matters dealing with fire safety such as dike design, building and structure spacing. The Fire Department, in most local-ities, has the responsibility of regulating ASTs. Unlike the UST, (unless the UST is leaking into a void or sew r system) the main threat involving the AST is the explosive or fire hazard associated with the product stored. If the AST presents a fire hazard to the surrounding community, the local fire department will more than likely require a permit and extensive fire equipment.

The ASTs that are presently regulated by the EPA are those storing hazardous wastes and those that are near water sources where the Clean Water Act applies. It is, however, only a matter of time before the federal EPA initiates regulations for all ASTs.

The Decision

There are situations where an AST is more practical than an UST. If the location is relatively remote, real estate is plentiful, esthetics is not a problem, it would be advantageous to have gravity flow from the storage tank and security is not a concern then perhaps an AST is in order.

Few if any of the above factors apply to most areas where storage tanks are most needed, mainly gasoline stations in towns and cities throughout the nation. Military bases, refining facilities and fuel transfer stations do, however, contain many of these factors and may well benefit by using ASTs. ASTs offer a distinct advantage over USTs in that gravity flow can be used to remove the product instead of pumping. This allows for much higher efficiency in moving large volumes of product. Another advantage of the AST over the UST is the number of different designs available. ASTs are available in sizes ranging from 275 gallons to over 10,000,000 gallons and come in many different shapes. In contrast, USTs usually do not exceed 30,000 gallons and are typically cylindrical in shape. A limiting factor in the design area is the material used for the AST. ASTs must be constructed of a material that will contain a liquid without the added support of surrounding soil. This rules out the use of FRP because it does not have the structural integrity to withstand the weight of liquid product without additional support of surrounding soil. At Military installations security may well dictate the use of USTs even if all other factors are in favor of the AST. As table 4.8 shows, another advantage of the AST is the less expensive liability insurance. However, cost is not listed as an advantage because the cost of an AST may be as much as that for an UST. Even if all the factors seem to be in favor of the AST, the requirement for items such as dikes, fire protection equipment, structural support, spill and overflow protection and maybe insulation to protect the stored product from temperature fluctuations, may well push the costs of an AST installation close to that of an UST.

Tanks in Vaults

A storage tank placed in an underground vault is considered an AST. Therefore, UST regulations do not apply. The advantage to this arrangement is the savings in land space and temperature control. However, the costs for installation are higher and gravity flow from the tank is no longer available.

In conclusion, although there are presently fewer regulations governing ASTs, this fact should not be used in choosing an AST because, as previously noted, it is just a matter of time before ASTs are federally regulated. With routine visual and olfactory (if the product is odoriferous) inspection it can be determined if product is leaking from an AST. For this reason leak detection equipment is not needed for an AST. And it may appear that ASTs offer less risk associated with the environment, but they obviously have limitations. Operating and maintenance costs, safety requirements and possibly insulation needs may drive the cost of the AST to be in the same neighborhood as the UST. With the latest improvements in the UST design, construction and installation, the new UST should experience few leaks. And if a leak does occur, with the new leak detection requirements, it should be discovered in time to correct it with little or no environmental damage.

The UST Market

The Jennings Group estimates that the UST Market for contracting and consulting will be in the neighborhood of $38 billon over the four years from 1991 to 1995. Estimates such as these are not unreasonable considering the huge population of older USTs. This cost estimate over a 4 year period may easily be realized if the actual population of leaking USTs is in the 700,000 range.

Figure 4.9 below shows a comparison of costs associated with leaking USTs. The costs are cumulative except for those shown at the 100 percent point where "Tank Only @ $36K ea" costs are indicated. This cost of $26.089 billion represents the costs if all leaking USTs were replaced at $36,000 each, excluding remediation. This is assuming, of course, that all the leaking tanks are replaced, which is not the result shown in the sample survey of figure 4.8. But for purposes of showing estimated costs on tank replacement only, cleanup costs are ignored.

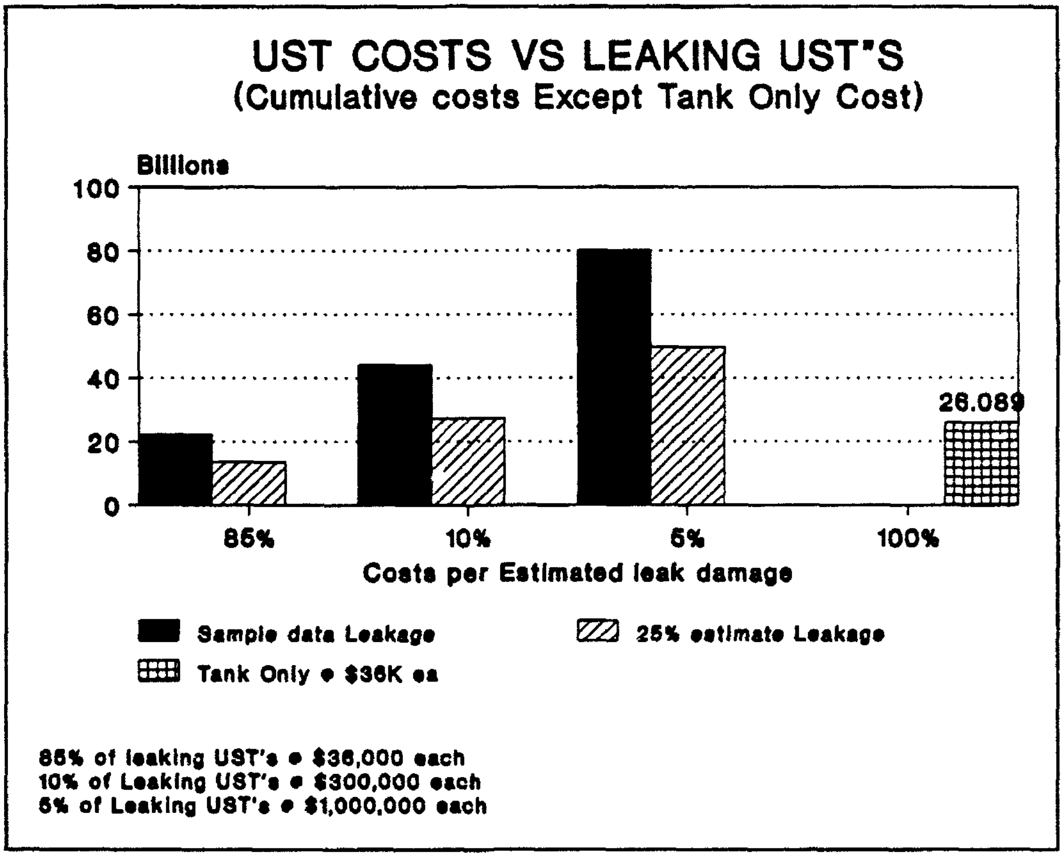


Figure 4.9. UST Costs Versus Leaking USTs

CHAPTER 5

CONCLUSIONS

Underground storage of liquid products in tanks will continue into the foreseeable future. Proper management of these tanks is the vital ingredient to an environmentally safe and effective UST program. The present regulations governing USTs should prove to be an effective management tool in insuring the proper safeguards are installed for safe and effective utilization of USTs.

Although there has been much needed improvement in the management of USTs there is still a long way to go before it can be stated that USTs are no longer causing an adverse impact to the environment. Regulations require tank owners to report leaks, closures, cleanups and other vital information about USTs to the EPA. This data is then compiled and updated on a quarterly basis. The second quarter of FY 92 data on the number of leaks, tank closures and cleanups reported to the EPA is shown below by EPA region in table 5.1. It is important to note that this data is reported data and does not include leaks that may have occurred but have not yet been discovered or reported. The data shows the number of completed cleanups to be 38,709 as of the second quarter of FY 92, or 31

March 92. Comparing this to the number of reported confirmed releases, 156,287 shows that there is a long way to go before the reported leaks are cleaned up.

Table 5.1.--Corrective Action Measures FY 92

Region	Number of Tanks	Confirmed Releases	Tanks Closed	Cleanups Completed
One	100,617	6,813	10,556	4,153
Two	109,399	10,915	23,785	5,218
Three	170,068	15,029	34,102	3,566
Four	322,280	27,387	112,118	6,874
Five	337,555	34,880	84,520	5,031
Six	183,456	13,586	29,767	2,969
Seven	62,537	10,588	29,033	2,646
Eight	69,945	6,977	21,213	1,903
Nine	155,591	23,812	16,522	4,683
Ten	54,165	6,300	30,644	1,666
Total	1,565,613	156,287	392,260	38,709

If the trend for reporting leaks is an indicator then there are many existing USTs leaking that have not yet been reported. For instance figure 4.5 in chapter 4 shows the number of confirmed releases to be 127,195 for the fourth quarter of FY 91. Table 5.1 above shows the number of releases as of the second quarter FY 92 to be 156,280. This is an increase of almost 23 percent in a period of 6 months. If the number of reported leaks continue to increase at this rate then by 1994 there will be an estimated 436,174 confirmed releases by USTs and by late 1995 the number of confirmed releases will be over 700,000. This supports the analysis in chapter 4 on the estimated number of leaks. Page 97 of the appendix is a national corrective action activity gragh showing this trend. These estimates are of course speculative. The EPA, however, [25] estimates that when all required information regarding USTs is reported there will be on the order of about 400,000 leaking USTs. A question that might be asked is: Why are there only 156,280 reported leaking USTs when all data indicates that the real number of leaking USTs is much larger? Once a leak is discovered it must be cleaned up and remediation costs can be extremely high. So part of the answer may be that some owners of USTs cannot afford to discover a leaking UST. And part of the answer is that, in spite of the requirement to report leaking USTs, enforcement of this item in the regulations regarding USTs has not been easy. The enforcement problem can be partially attributed to the down turn in the economy but some of it is the fact that many of the existing USTs are owned by operators, with not only financial limitations, but with multiple tanks that make it hard for them to meet the new regulations in the time required.

However, for those owners with limited finances, the financial burden associated with upgrading USTs will probably not be lessened with time. Because if unprotected steel tanks are allowed continued operation, after 10 years, many will eventually leak and require corrective action. This will prove to be much more financially burdensome than upgrading or replacing exist-ing USTs. Again, risk management is in order here to determine what action should be taken. If the required actions are put off to a later date not only are fines for non-conformance a potential cost but also the clean up efforts associated with leaking USTs are, as discussed in chapter 3, very costly. An existing UST may not be leak-ing today and if upgraded to meet the new standards may never leak. If on the other hand the same UST is not up-graded it may develop a leak in one or two years requiring expensive cleanup and disposal costs. The precept here is "pay a little now or pay a lot later."

In reality, any owner of USTs should seriously consider upgrading to meet the new regulations, not just because of the negative impact leaking USTs have on the environment but also because in the long run all USTs will have to conform to the new regulations and further delay will only add to the costs.

The most aggressive single group to implement the new regulations and upgrade their existing USTs is the oil companies [16]. This is probably because they not only have an invested interest in maintaining a positive environmental perception of the petroleum industry, but also have the capital to implement the required upgrades.

USTs Abandoned In Place

Little has been mentioned of those USTs that have been placed in a state of indecision, specifically those USTs "abandoned in place" which have been left for future demise. Are there a significant number of these USTs? Data indicates that USTs in this category are significant in numbers. A survey of 1,546 USTs that belonged to one owner showed that 650 of these were designated as "abandoned in place" (AIP). The fate of the USTs placed in the AIP category is yet to be determined but meanwhile further action to upgrade, replace or remove is delayed until either time or money allows for it. Most will probably be closed out by removal and disposal followed by any required remediation. The number of 650 USTs for the above survey represents 42 percent of the total population of USTs in this specific owners possession. Herein lies another possible answer to why many leaking USTs have not been reported. USTs abandoned in place are typically the last to be upgraded by monitoring and leak testing because they are not in use and do not require immediate attention by the owner for operational requirements.

APPENDIX

Data contained in this appendix is public information and can be obtained by requests from the Federal EPA.

STARS 4 QTR. FY 91

Region/State	NUMBER OF TANKS	CLOSURES	CONFIRMED RELEASES
ONE			
CT	30,574	1,224	1,205
MA	30,986	2,000	2,775
ME	23,217	4,982	803
NH	11,096	1,157	449
RI	6,271	1,027	251
VT	6,252	1,375	754
TOTAL (Region 1)	108,396	11,765	6,237
TWO			
NJ	47,977	1,219	3,073
NY	85,410	18,581	6,666
PR	6,420	98	111
VI	273	34	12
TOTAL (Region 2)	140,080	19,932	9,862
THREE			
DC	9,776	266	250
DE	7,419	1,202	891
MD	29,472	3,564	6,394
PA	90,321	11,551	1,771
VA	62,328	7,822	2,890
WV	14,247	2,335	484
TOTAL (Region 3)	213,563	26,740	12,680
FOUR			
AL	33,262	2,704	1,063
FL	92,407	43,932	9,242
GA	38,485	5,771	1,359
KY	31,347	3,165	1,554
MS	20,389	4,502	411
NC	84,060	24,367	2,991
SC	34,090	3,670	1,480
TN	42,512	10,549	1,311
TOTAL (Region 4)	376,552	98,660	19,411
FIVE			
IL	61,792	5,743	5,808
IN	41,058	2,508	1,619
MI	72,275	23,690	5,401
MN	36,032	4,820	4,372
OH	74,959	9,479	3,730
WI	53,190	7,295	4,798
TOTAL (Region 5)	339,306	53,535	25,728

STARS 4 QTR. FY 91

Region/State	NUMBER OF TANKS	CLOSURES	CONFIRMED RELEASES
SIX			
AR	16,202	2,371	202
LA	26,658	5,954	1,143
NM	12,290	2,274	616
OK	27,924	1,644	918
TX	132,954	12,998	8,647
TOTAL (Region 6)	**216,028**	**25,241**	**11,526**
SEVEN			
IA	26,125	11,020	3,827
KS	22,125	3,532	2,149
MO	24,534	3,323	1,396
NE	17,658	4,276	1,457
TOTAL (Region 7)	**90,440**	**22,151**	**8,829**
EIGHT			
CO	23,277	3,646	2,033
MT	21,154	2,650	721
ND	8,186	717	337
SD	7,889	673	922
UT	12,882	4,521	1,239
WY	8,054	2,613	835
TOTAL (Region 8)	**81,442**	**14,820**	**6,087**
NINE			
AZ	19,888	8,087	1,846
CA	133,552	3,996	18,074
HI	5,195	287	293
NV	6,576	2,377	892
CQ	70	1	1
GU	446	82	67
SA	56	0	0
TOTAL (Region 9)	**165,783**	**14,830**	**21,173**
TEN			
AK	4,957	854	358
ID	9,124	1,923	394
OR	17,240	11,064	2,657
WA	25,594	13,343	1,874
TOTAL (Region 10)	**56,915**	**27,184**	**5,283**
NATIONAL TOTAL	**1,788,505**	**314,858**	**127,195**

STARS 4 QTR. FY 91

Region/State	CLEANUPS INITIATED			
ONE	RP	TF	STATE	TOTAL
CT	1,152	12	13	1,177
MA	2,303	3	42	2,348
ME	724	7	62	793
NH	450	5	0	455
RI	252	7	0	259
VT	725	19	10	754
TOTAL (Region 1)	5,606	53	127	5,786
TWO	RP	TF	STATE	TOTAL
NJ	2,279	6	3	2,288
NY	5,989	28	620	6,637
PR	109	0	0	109
VI	11	0	0	11
TOTAL (Region 2)	8,388	34	623	9,045
THREE	RP	TF	STATE	TOTAL
DC	190	1	0	191
DE	573	4	12	589
MD	5,610	14	1	5,625
PA	1,437	1	0	1,438
VA	2,057	19	8	2,084
WV	360	2	0	362
TOTAL (Region 3)	10,227	41	21	10,289
FOUR	RP	TF	STATE	TOTAL
AL	233	30	406	669
FL	1,587	0	395	1,982
GA	895	0	4	899
KY	1,560	17	0	1,577
MS	47	2	135	184
NC	2,205	23	2	2,230
SC	389	7	0	396
TN	561	29	0	590
TOTAL (Region 4)	7,477	108	942	8,527
FIVE	RP	TF	STATE	TOTAL
IL	4,635	10	2	4,647
IN	1,337	12	13	1,362
MI	4,153	67	29	4,249
MN	1,942	4	1	1,947
OH	3,121	4	0	3,125
WI	4,318	23	0	4,341
TOTAL (Region 5)	19,506	120	45	19,671

STARS 4 QTR. FY 91

CLEANUPS INITIATED

SIX	RP	TF	STATE	TOTAL
AR	160	0	0	160
LA	574	2	0	576
NM	447	8	2	457
OK	325	0	0	325
TX	6,316	8	15	6,339
TOTAL (Region 6)	7,822	18	17	7,857

SEVEN	RP	TF	STATE	TOTAL
IA	702	0	0	702
KS	1,910	3	0	1,913
MO	1,151	4	1	1,156
NE	55	1	0	56
TOTAL (Region 7)	3,818	8	1	3,827

EIGHT	RP	TF	STATE	TOTAL
CO	1,072	2	0	1,074
MT	580	13	1	594
ND	295	1	0	296
SD	753	1	0	754
UT	462	2	0	464
WY	298	1	116	415
TOTAL (Region 8)	3,460	20	117	3,597

NINE	RP	TF	STATE	TOTAL
AZ	585	1	0	586
CA	5,621	0	0	5,621
HI	168	0	0	168
NV	590	3	78	671
CQ	0	0	0	0
GU	66	0	0	66
SA	0	0	0	0
TOTAL (Region 9)	7,030	4	78	7,112

TEN	RP	TF	STATE	TOTAL
AK	219	1	1	221
ID	310	1	0	311
OR	1,492	5	3	1,500
WA	1,758	1	4	1,763
TOTAL (Region 10)	3,779	8	8	3,795

National Sub-totals	77,113	414	1,979	

Cleanups Initiated Nationally 79,506

STARS 4 QTR. FY 91

Region/State	SITES UNDER CONTROL			
One	RP	TF	STATE	TOTAL
CT	1,058	8	12	1,078
MA	2,156	3	58	2,217
ME	679	3	36	718
NH	441	8	3	452
RI	250	2	0	252
VT	727	19	8	754
TOTAL (Region 1)	5,311	43	117	5,471
TWO	RP	TF	STATE	TOTAL
NJ	1,840	6	3	1,849
NY	3,865	22	443	4,330
PR	109	0	0	109
VI	11	0	0	11
TOTAL (Region 2)	5,825	28	446	6,299
THREE	RP	TF	STATE	TOTAL
DC	173	1	0	174
DE	291	0	2	293
MD	5,467	12	1	5,480
PA	1,150	1	0	1,151
VA	458	12	1	471
WV	330	0	0	330
TOTAL (Region 3)	7,869	28	4	6,651
FOUR	RP	TF	STATE	TOTAL
AL	202	15	344	561
FL	1,641	0	192	1,833
GA	248	0	0	248
KY	1,059	10	0	1,069
MS	35	6	66	107
NC	1,570	8	1	1,579
SC	333	4	0	337
TN	429	3	0	432
TOTAL (Region 4)	5,517	46	603	6,166
FIVE	RP	TF	STATE	TOTAL
IL	4,635	10	2	4,647
IN	1,116	0	0	1,116
MI	4,315	0	0	4,315
MN	1,211	3	0	1,214
OH	757	0	0	757
WI	859	17	0	876
TOTAL (Region 5)	12,893	30	2	12,925

STARS 4 QTR. FY 91

Region/State	SITES UNDER CONTROL			
SIX	RP	TF	STATE	TOTAL
AR	111	0	0	111
LA	553	2	0	555
NM	331	4	0	335
OK	541	1	0	542
TX	4,696	0	1	4,697
TOTAL (Region 6)	**6,232**	**7**	**1**	**6,240**
SEVEN	RP	TF	STATE	TOTAL
IA	702	0	0	702
KS	1,407	0	0	1,407
MO	922	3	1	926
NE	31	0	0	31
TOTAL (Region 7)	**3,062**	**3**	**1**	**3,066**
EIGHT	RP	TF	STATE	TOTAL
CO	296	0	0	296
MT	576	5	1	582
ND	243	0	0	243
SD	709	0	0	709
UT	296	0	0	296
WY	230	1	81	312
TOTAL (Region 8)	**2,350**	**6**	**82**	**2,438**
NINE	RP	TF	STATE	TOTAL
AZ	366	1	0	367
CA	3,375	0	0	3,375
HI	74	0	0	74
NV	569	0	39	608
CQ	0	0	0	0
GU	50	0	0	50
SA	0	0	0	0
TOTAL (Region 9)	**4,434**	**1**	**39**	**4,474**
TEN	RP	TF	STATE	TOTAL
AK	146	6	1	153
ID	302	0	0	302
OR	1,248	0	0	1,248
WA	1,572	1	4	1,577
TOTAL (Region 10)	**3,268**	**7**	**5**	**3,280**
National Sub-totals	56,761	197	1,300	

Sites Under Control Nationally 57,010

STARS 4 QTR. FY 91

Region/State	CLEANUPS COMPLETED			
ONE	RP	TF	STATE	TOTAL
CT	832	2	2	836
MA	1,767	0	8	1,775
ME	643	0	37	680
NH	163	0	0	163
RI	129	2	0	131
VT	387	0	2	389
TOTAL (Region 1)	3,921	4	49	3,974
	CLEANUPS COMPLETED			
TWO	RP	TF	STATE	TOTAL
NJ	101	2	1	104
NY	3,865	1	443	4,309
PR	36	0	0	36
VI	0	0	0	0
TOTAL (Region 2)	4,002	3	444	4,449
THREE	RP	TF	STATE	TOTAL
DC	117	1	0	118
DE	215	0	0	215
MD	1,786	0	0	1,786
PA	343	0	0	343
VA	298	8	1	307
WV	136	0	0	136
TOTAL (Region 3)	2,895	9	1	2,905
FOUR	RP	TF	STATE	TOTAL
AL	63	30	144	237
FL	269	0	47	316
GA	164	0	0	164
KY	672	0	0	672
MS	26	2	42	70
NC	552	3	0	518
SC	43	0	0	43
TN	235	0	0	235
TOTAL (Region 4)	2,024	35	233	2,292
FIVE	RP	TF	STATE	TOTAL
IL	704	1	0	705
IN	78	0	0	78
MI	507	0	0	507
MN	857	0	0	857
OH	293	0	0	293
WI	548	9	0	557
TOTAL (Region 5)	2,987	10	0	2,997

STARS 4 QTR. FY 91

Region/State	CLEANUPS COMPLETED			
SIX	RP	TF	STATE	TOTAL
AR	30	0	0	30
LA	429	0	0	429
NM	206	0	0	206
OK	365	0	0	365
TX	894	0	0	894
TOTAL (Region 6)	**1,924**	**0**	**0**	**1,924**
SEVEN	RP	TF	STATE	TOTAL
IA	385	0	0	385
KS	896	0	0	896
MO	826	0	1	827
NE	6	0	0	6
TOTAL (Region 7)	**2,113**	**0**	**1**	**2,114**
EIGHT	RP	TF	STATE	TOTAL
CO	282	0	0	282
MT	245	3	0	248
ND	185	0	0	185
SD	228	0	0	228
UT	142	1	0	143
WY	242	0	59	301
TOTAL (Region 8)	**1,324**	**4**	**59**	**1,387**
NINE	RP	TF	STATE	TOTAL
AZ	306	0	0	306
CA	2,420	0	0	2,420
HI	0	0	0	0
NV	447	0	48	495
CQ	0	0	0	0
GU	40	0	0	40
SA	0	0	0	0
TOTAL (Region 9)	**3,213**	**0**	**48**	**3,261**
TEN	RP	TF	STATE	TOTAL
AK	55	1	1	57
ID	173	0	0	173
OR	730	0	0	730
WA	368	0	35	403
TOTAL (Region 10)	**1,326**	**1**	**36**	**1,363**
National Sub-totals	25,729	66	871	

Cleanups Completed Nationally 26,666

STARS 4 QTR. FY 91

Region/State	Emergency Responses	Enforcement Actions
ONE		
CT	28	371
MA	1,772	1,607
ME	165	34
NH	182	638
RI	14	251
VT	76	112
TOTAL (Region 1)	**2,237**	**3,013**
TWO		
NJ	44	2,558
NY	46	5,989
PR	53	36
VI	3	9
TOTAL (Region 2)	**146**	**8,592**
THREE		
DC	11	88
DE	103	779
MD	148	1,255
PA	27	302
VA	36	2,890
WV	16	140
TOTAL (Region 3)	**341**	**5,454**
FOUR		
AL	73	1,063
FL	111	2,587
GA	7	5
KY	115	785
MS	38	8
NC	140	518
SC	11	63
TN	5	1,311
TOTAL (Region 4)	**500**	**6,340**
FIVE		
IL	61	188
IN	20	549
MI	194	2,324
MN	12	4,372
OH	18	204
WI	158	349
TOTAL (Region 5)	**463**	**7,986**

STARS 4 QTR. FY 91

Region/State	Emergency Responses	Enforcement Actions
SIX		
AR	6	113
LA	130	586
NM	31	129
OK	13	509
TX	35	5,649
TOTAL (Region 6)	215	6,986
SEVEN		
IA	200	3,358
KS	55	9
MO	77	27
NE	2	12
TOTAL (Region 7)	334	3,406
EIGHT		
CO	100	37
MT	2	579
ND	0	1
SD	4	12
UT	9	12
WY	33	310
TOTAL (Region 8)	153	951
NINE		
AZ	13	1,011
CA	156	3,972
HI	0	52
NV	6	253
CQ	0	1
GU	63	0
SA	0	0
TOTAL (Region 9)	238	5,289
TEN		
AK	4	109
ID	9	181
OR	45	174
WA	19	0
TOTAL(Region 10)	77	464
NATIONAL TOTAL	4,704	48,481

Corrective Action Measures For Third Quarter FY 92

Region/State	Number of Tanks	Tanks Closed	Confirmed Releases	Cleanups Initiated	Sites Under Control	Cleanups Completed
ONE						
CT	34792	1288	1265	1237	1143	869
MA	24825	7709	3247	2751	2598	1916
ME	17134	5022	895	877	798	734
NH	13366	1651	522	522	508	216
RI	6264	1297	320	320	313	163
VT	4236	1602	876	876	876	403
SUBTOTAL	100,617	18,569	7,119	6,583	6,236	4,301
TWO						
NJ	51558	3020	3809	2822	2419	671
NY	51006	40982	7590	7520	4966	4940
PR	6555	411	123	123	116	41
VI	280	50	13	12	12	0
SUBTOTAL	109,399	44,463	11,534	10,477	7,513	5,652
THREE						
DC	5041	414	323	239	189	157
DE	6492	1799	1162	858	509	420
MD	21659	6174	8298	7490	6526	2573
PA	66289	15583	2160	1750	1296	362
VA	52648	10949	3568	2547	619	363
WV	17939	2821	718	438	410	48
SUBTOTAL	170,068	37,740	16,229	13,322	9,549	3,923
FOUR						
AL	31271	3757	1414	867	799	436
FL	57615	50651	10877	2949	2756	608
GA	51233	7812	1868	1324	466	307
KY	34133	4759	2402	2400	1210	940
MS	17181	5856	491	359	242	167
NC	60309	29303	3992	3225	2537	894
SC	26295	5541	2728	328	161	39
TN	44243	15588	6844	5839	5656	5376
SUBTOTAL	322,280	123,267	30,616	17,291	13,827	8,767

Region/State	Number of Tanks	Tanks Closed	Confirmed Releases	Cleanups Initiated	Sites Under Control	Cleanups Completed
FIVE						
IL	63922	11318	7807	6582	6582	1130
IN	29227	18526	2759	1387	1116	243
MI	69133	29635	6934	6455	6007	884
MN	33033	3577	3542	2905	1752	1272
OH	74959	12497	9824	8586	8575	1960
WI	67281	14621	6192	5323	1159	774
SUBTOTAL	337,555	90,174	37,058	31,238	25,191	6,263
SIX						
AR	16030	2734	261	201	126	10
LA	25265	6628	1348	629	608	508
NM	8411	3223	860	609	480	336
OK	29384	1830	1151	392	392	388
TX	104366	17526	11082	7,335	6095	2025
SUBTOTAL	183,456	31,941	14,702	9,166	7,701	3,267
SEVEN						
IA	15904	17851	4228	813	813	473
KS	15331	10508	2664	2383	1715	1165
MO	20443	6000	1966	1686	1302	1182
NE	10859	6352	1749	257	161	117
SUBTOTAL	62,537	40,711	10,607	5,139	3,991	2,937
EIGHT						
CO	22246	4938	2371	1508	519	470
MT	12828	6501	1034	779	739	292
ND	8030	910	436	389	292	232
SD	8325	1079	1186	971	879	413
UT	10299	6108	1496	1066	635	381
WY	8217	2921	973	469	406	331
SUBTOTAL	69,945	22,457	7,496	5,182	3,470	2,119

Region/State	Number of Tanks	Tanks Closed	Confirmed Releases	Cleanups Initiated	Sites Under Control	Cleanups Completed
NINE						
AZ	18540	9299	2261	1537	1072	496
CA	124872	4516	20656	7760	4899	3728
HI	5618	424	444	197	80	2
NV	5986	2650	1068	800	771	586
CQ	89	14	2	2	2	0
GU	433	109	70	70	70	50
SA	53	0	2	2	0	0
SUBTOTAL	155,591	17,012	24,503	10,368	6,894	4,862
TEN						
AK	5847	2244	543	392	371	139
ID	8493	2200	517	408	408	240
OR	16105	11600	3386	1998	1388	1040
WA	23720	15158	2414	2210	1987	498
SUBTOTAL	54,165	31,202	6,860	5,008	4,154	1,917

	Number of Tanks	Tanks Closed	Confirmed Releases	Cleanups Initiated	Sites Under Control	Cleanups Completed
National Total	1,565,613	457,536	166,731	113,774	88,526	44,008

Corrective Action Measures For Third Quarter FY 92

Region/State	Emergency Responses	Enforcement Actions
ONE		
CT	35	383
MA	2079	1781
ME	188	48
NH	182	826
RI	14	312
VT	82	123
SUBTOTAL	2,580	3,473
TWO		
NJ	49	2889
NY	51	6725
PR	69	42
VI	4	9
SUBTOTAL	173	9,665
THREE		
DC	14	123
DE	135	945
MD	179	1422
PA	47	406
VA	37	3568
WV	19	376
SUBTOTAL	431	6,840
FOUR		
AL	96	1252
FL	129	2609
GA	7	6
KY	123	1592
MS	54	497
NC	170	977
SC	11	66
TN	8	1750
SUBTOTAL	598	8,749

Region/State	Emergency Responses	Enforcement Actions
FIVE		
IL	210	311
IN	22	617
MI	241	2392
MN	74	3597
OH	246	246
WI	187	966
SUBTOTAL	980	8,129
SIX		
AR	6	138
LA	158	595
NM	38	519
OK	16	642
TX	75	7702
SUBTOTAL	293	9,596
SEVEN		
IA	203	3529
KS	60	10
MO	89	26
NE	2	11
SUBTOTAL	354	3,576
EIGHT		
CO	121	37
MT	2	13
ND	5	0
SD	6	12
UT	9	24
WY	44	310
SUBTOTAL	187	396

Region/State	Emergency Responses	Enforcement Actions
NINE		
AZ	15	1030
CA	162	5278
HI	0	52
NV	14	407
CQ	0	0
GU	63	0
SA	0	2
SUBTOTAL	254	6,769
TEN		
AK	4	169
ID	9	226
OR	51	176
WA	21	50
SUBTOTAL	85	621

	Emergency Responses	Enforcement Actions
National Total	5,935	57,814

Leak Detection Compliance Measures For Third Quarter FY 92

Region/State	Facilities Required to Submit Evidence??	Facilities Judged to Be in Compliance	Facilities Inspected	Facilities Judged to Be in Compliance	Informal Enforcement Orders Issued	Formal Enforcement Orders Issued
ONE						
CT	4300	1100	33	4	48	23
MA	0	0	0	0	0	0
ME	7900	3375	39	18	60	11
NH	1310	611	108	108	190	0
RI	273	270	12	0	54	8
VT	757	662	220	146	413	75
SUBTOTAL	14,540	6,018	412	276	765	117
TWO						
NJ	331	261	10	10	0	0
NY	2212	1079	18	10	0	1
PR	182	0	242	0	71	0
VI	157	85	76	39	59	25
SUBTOTAL	2,882	1,425	346	59	130	26
THREE						
DC	348	187	14	11	170	4
DE	117	97	211	141	97	19
MD	27	22	1238	104	1196	22
PA	0	0	0	0	0	0
VA	178	97	70	68	21	302
WV	1903	59	112	81	4	56
SUBTOTAL	2,573	462	1,645	405	1,488	403
FOUR						
AL	0	0	1672	1535	150	503
FL	0	0	61405	0	0	0
GA	61	9	107	16	7	22
KY	1176	260	0	0	40	0
MS	1760	876	55	53	608	32
NC	0	0	118	40	78	0
SC	173	173	20	20	0	0
TN	6215	2594	0	0	6215	0
SUBTOTAL	9,385	3,912	63,377	1,664	7,098	557

Region/State	Facilities Required to Submit Evidence	Facilities Judged to Be in Compliance	Facilities Inspected	Facilities Judged to Be in Compliance	Informal Enforcement Orders Issued	Formal Enforcement
FIVE						
IL	3183	3183	0	0	0	185
IN	0	0	0	0	0	0
MI	5788	5093	783	175	266	0
MN	0	0	17	0	0	0
OH	25583	0	186	170	6	0
WI	9760	649	61	0	0	0
SUBTOTAL	44,314	8,925	1,047	345	272	185
SIX						
AR	5380	2900	42	30	8	0
LA	990	990	871	774	92	5
NM	0	0	1453	1087	0	366
OK	0	0	568	413	64	3
TX	19173	8090	1981	1962	9551	4
SUBTOTAL	25,543	11,980	4,915	4,266	9,715	378
SEVEN						
IA	0	0	979	266	51	1
KS	5391	4852	40	40	640	2
MO	0	0	731	358	53	28
NE	0	0	998	143	558	0
SUBTOTAL	5,391	4,852	2,748	807	1,302	31
EIGHT						
CO	345	316	209	191	20	0
MT	0	0	274	221	21	1
ND	684	681	63	9	373	11
SD	2890	801	410	288	94	0
UT	2126	1758	71	29	23	10
WY	2798	388	13	2	108	4
SUBTOTAL	8,843	3,944	1,040	740	639	26

Region/State	Facilities Required to Submit Evidence	Facilities Judged to Be in Compliance	Facilities Inspected	Facilities Judged to Be in Compliance	Informal Enforcement Orders Issued	Formal Enforcement
NINE						
AZ	4598	2166	322	134	60	0
CA	130573	87548	9163	7057	2749	353
HI	1070	862	33	21	227	0
NV	224	170	90	85	89	7
CQ	82	12	4	5	0	0
GU	46	43	46	43	2	0
SA	49	49	53	51	4	0
SUBTOTAL	136,642	90,850	9,711	7,396	3,131	360
TEN						
AK	3091	1054	25	6	28	0
ID	0	0	111	80	30	9
OR	0	0	4	2	2	0
WA	6654	5221	458	377	126	0
SUBTOTAL	9,745	6,275	598	465	186	9

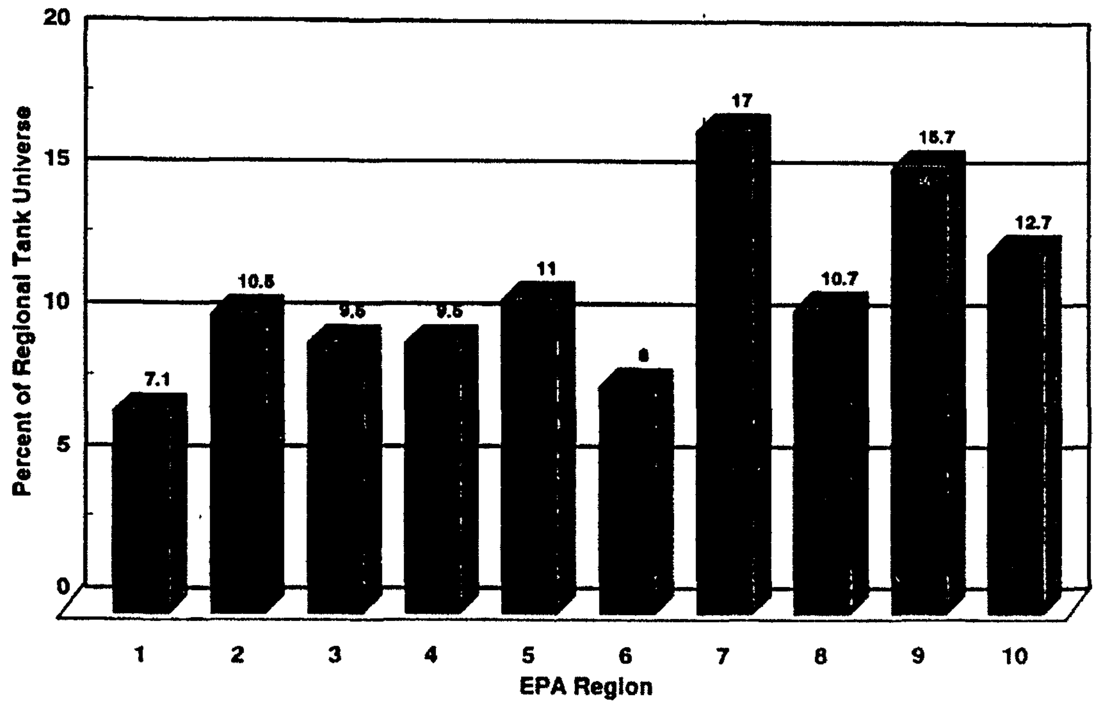
	Facilities Required to Submit Evidence	Facilities Judged to Be in Compliance	Facilities Inspected	Facilities Judged to Be in Compliance	Informal Enforcement Orders Issued	Formal Enforcement Orders Issued
National Total	259,858	138,643	85,839	16,423	24,726	2,092

[a]These totals include actions taken by the Regions to promote compliance within their States.

[b]Totals are cumulative since 1st quarter FY 1991.

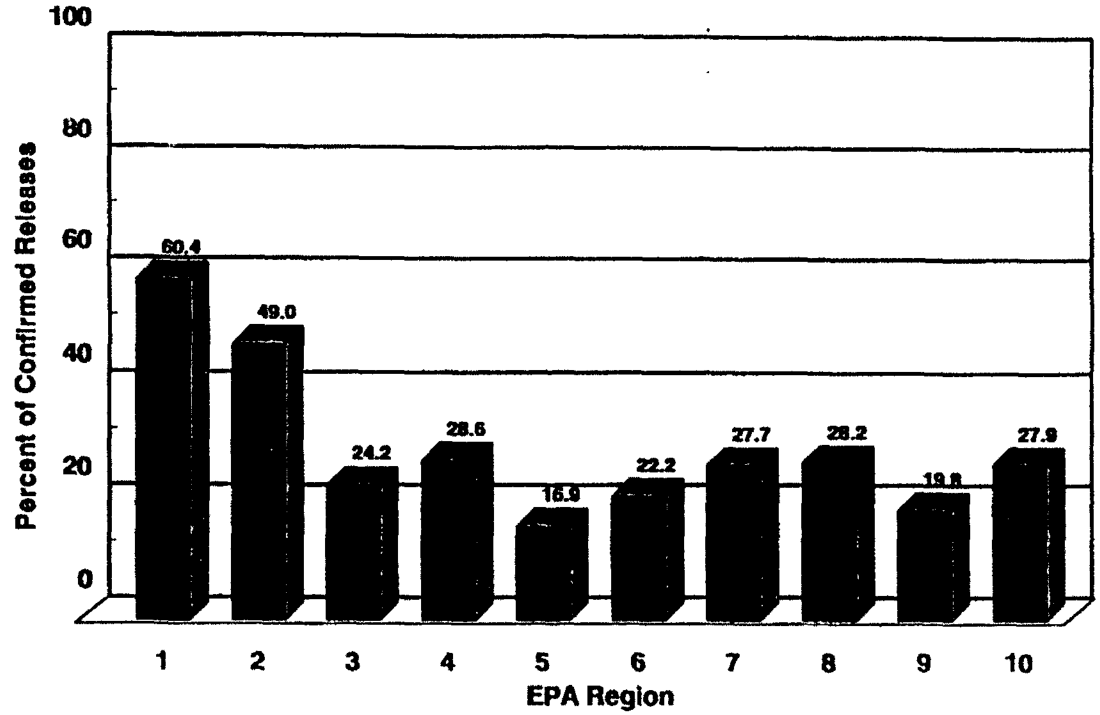
Third Quarter FY 1992

Confirmed Releases as a Percentage of Each Region's Tank Universe



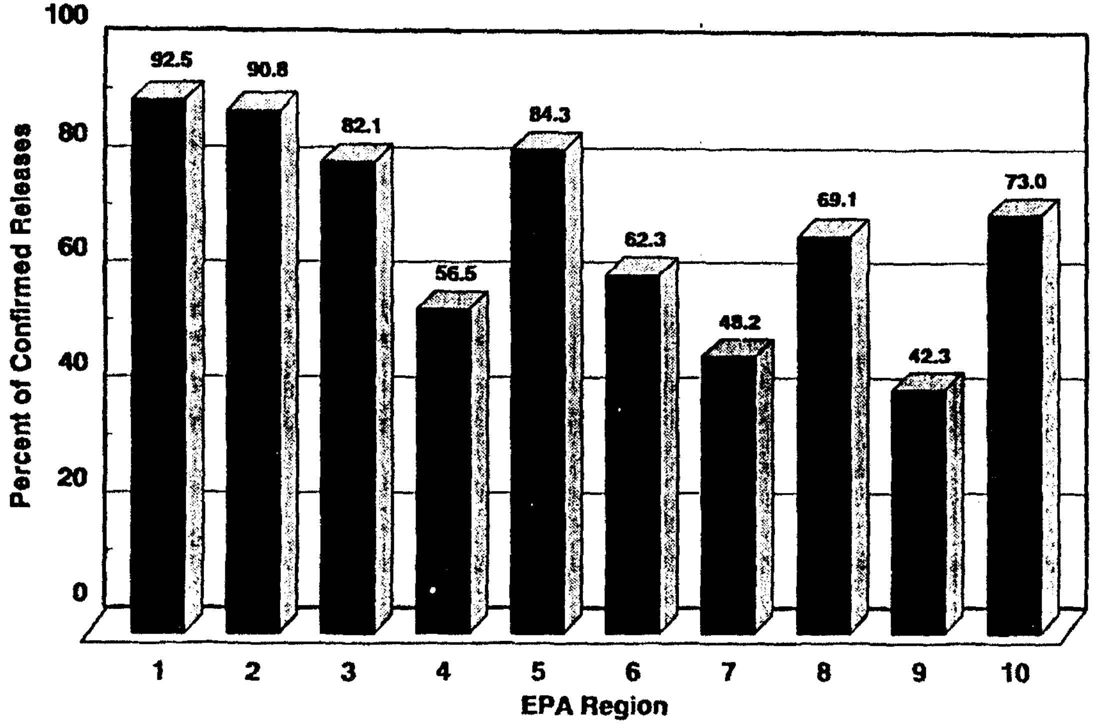
Third Quarter FY 1992

Cleanups Completed as a Percentage of Confirmed Releases in Each Region



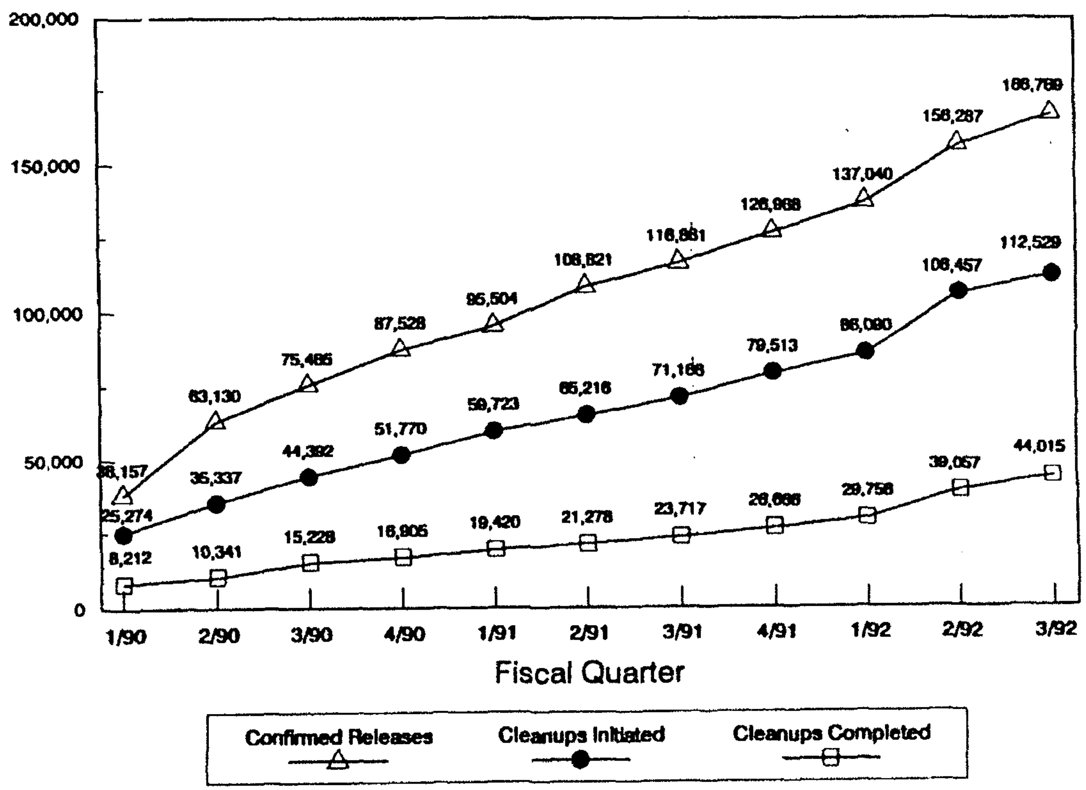
Third Quarter FY 1992

Cleanups Initiated as a Percentage of Confirmed Releases in Each Region



National Corrective Action Activity

Through June 30, 1992



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